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TO CORRESPONDENTS.

X. Y. Z.—1. *Yes.*—2. *A loss.*—3. *From* 1 *to* 15 *per cent.*—4. *No.*

Real Cannel Coal Gas *must authorise us to add his signature to his letter before we can publish it.*

NOTICES.

Subscribers who have not paid their subscriptions in advance are requested to remit 6*s. in discharge of the half year now expired, or* 11*s. for the current year.*

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Back numbers exceeding three months' date will in future be charged double price, unless six or more consecutive numbers are taken at the same time. Nos. 6, 15, 18, and 23, are out of print; and Nos. 24, 25, and 26, can only be had with the entire series, forming volume 2.

The Editor will be particularly obliged by his friends forwarding to him Notices of all Meetings, Trials, or Appeals, which it may be interesting to the Gas World to have reported.

Circular to Gas Companies.

The Editor may be consulted on all subjects connected with the supply and manufacture of gas, or the alteration and improvement of gas apparatus, and the construction of new works.

A document has just been issued by the promoters of the hydro-carbon process, which, for the absurdity of its speculative conclusions, is without parallel in the annals of gas lighting since the appearance of Mr. Winsor's well-known prospectus of his "National Light and Heat Company;" but, as a copy of it has been forwarded to every gas company in the United Kingdom, there is no necessity for its repetition in our columns. After the exhibition of practical ignorance of the details of the cost and manufacture of gas, shown by the almost octogenarian Clegg, in many of his reports, as one of the surveying officers appointed by the Commissioners of Woods and Forests for conducting the preliminary inquiries into the position of gas works soliciting acts of incorporation, and his more recent performances in connection with Dr. Leeson and Professor Graham, for the purpose of determining the illuminating power of the gas supplied to the citizens of London in 1849, his brother gas engineers have ceased to place that confidence in his judgment which they were really desirous of according to one who in his early days had, by his genius, contributed to the overcoming of some of the difficulties which invariably attend the perfecting of any new manufacture. But when it is further borne in mind that no gas engineer can at all approach Mr. Clegg in regard to the amount of money squandered under their direction in impracticable and useless experiments while connected with the manufacture of gas, or present a catalogue of an equal number of abortive schemes launched during the thirty years of his subsequent equivocal connection with it, little surprise will be excited that one more should be added to the list, or that a man of his sanguine temperament should have been suddenly converted by a project offering a new field for the exercise of his constructive genius.

The "Report on the Commercial Advantages of White's Patent Hydro-Carbon Process of making Gas from Cannels, &c.," is, we understand, the pilot which is to precede the bringing forward of a metropolitan hydro-carbon gas company on a scale sufficiently extensive to swallow up all the others, and for which Mr. Clegg is to be the engineer-in-chief. After unsuccessfully knocking at the door of every metropolitan gas company, and receiving for answer from many of them, that, having carefully examined the question, they could discover nothing novel or economical in the process—which had, besides, been open to the British public for upwards of 15 years—its present promoters have resolved, as a last resort, to become gas manufacturers themselves, if the metropolitan public will furnish them with the means. Had they merely offered their services to the gas companies as water-gas manufacturers at Mr. Clegg's estimate of 5d. per 1000 feet, with a fair profit added for their trouble, the negotiations might have been attended with a different result; and if they are even now disposed to show the *bond fide* character of their estimates, by undertaking the manufacture of purified water gas, half hydrogen and half carbonic oxide, at 6d. per 1000 feet, as measured into the gasholders—finding good security for the performance of their engagements—we have little doubt that the majority of the London gas companies would gladly accept their offers, and bear all the expenses of the conversion of their establishments into hydro-carbon gas manufactories. Such a contract would, according to Mr. Clegg, leave a profit of 20 per cent. on the cost of manufacture; and a profit like this ought to content the Lancashire men who make a boast of their preference for "a nimble ninepence to a slow shilling." It, however, behoves gas companies in general to be on their guard against this renewed agitation, and by the timely examination and determination by competent and disinterested parties, of the quality and purity of the gas they are now supplying to the public, prevent the repetition of the disgraceful trickery by which the gases of the companies of the City of London were attempted to be discredited in 1849 and 1850.

Mr. Clegg has blindly followed in the wake of Dr. Frankland, and endorsed all his errors and conclusions, without giving any details of the experiments made by himself. That he has never made purified water gas on a large scale, or has any other but a theoretical and speculative idea of its cost, is evident from the estimate he puts forward, and its utter discordance with his own figures, as to the materials consumed in its manufacture. He seems, indeed, to have fallen into the usual error of *every* inexperienced water-gas manufacturer,

in largely underrating its cost, and, consequently, in over-estimating the value of the process; for if it should turn out, after all, that non-illuminating purified water gas is as costly in its manufacture as other gases which possess *some* illuminating qualities, however small, then, *cadit questio*, the whole process falls to the ground; and this, we apprehend, will be the rock upon which it will be wrecked.

Mr. Clegg's estimate of the cost of producing water gas in London is 5d. per 1000 feet. He groups the items thus:—

	d.	
Fuel	1·5	per 1000 feet.
Labour	·625	,,
Repairs of retorts, mains, &c. .	2·458	,,
Coke to decompose water (16 lb.)	·417	,,
Total . . .	5·000	,,

He further says that "In small towns, mills, &c., it will be unfair to estimate the cost of the water gas as given above. It will be considerably less, as an extra retort or two for its generation can be put into small ovens without any increase in fuel."

To enable our readers to test the accuracy of these estimates for themselves, it will be necessary briefly to explain the nature of the decompositions and recombinations which take place in the manufacture of water gas, and the conditions essential to its successful practice.

The constituents of water are well known to be two volumes of hydrogen and one volume of oxygen; and that, by the application of heat in conjunction with the presence of some material having a greater affinity for oxygen than hydrogen has, water may be decomposed into the two elementary bodies above mentioned. If pure hydrogen gas is required to be produced, iron or some other easily oxidized metal, in a minute state of division, is presented, by which the oxygen is attracted, and the free hydrogen liberated. In the water-gas manufacture, carbon is employed instead of iron: the carbon entering into combination with the oxygen of the water, and becoming carbonic acid or carbonic oxide, according to the temperature at which the recombination takes place; and the resulting gases, from the joint decomposition of the water and carbon, are, consequently, hydrogen, carbonic acid, and carbonic oxide, or impure water gas, as it should be denominated, being contaminated by the presence of carbonic acid, a gas which, from its injurious action upon the combustion of the two other gases, must be got rid of by subsequent purification. No one has hitherto succeeded in manufacturing water gas, *at one operation*, into the composition of which carbonic acid does not enter, more or less, varying in proportions from 5 to 25 per cent. This would appear to arise from the impossibility in any of the apparatus used for the purpose, of maintaining the entire mass of carbon at a sufficiently high temperature to induce it to yield up the double volume required to constitute carbonic oxide out of some portion of the oxygen coming in contact with it. The consequence is that in practice, even when working with the best-constructed apparatus, and at a temperature as high as iron retorts can be safely heated to, the carbonic acid produced is about one-tenth of the whole volume of the water gases.

The following table exhibits at a glance the decompositions which 26·4lb. of water and 14·4lb. of carbon undergo, and the recombinations of their constituents, by which 1000 feet of impure water gas are produced, equalling in weight the original materials employed:—

lb.			lb.			lb.
26·39577 water . .	Hydrogen . .				550 feet =	2·93145
	Oxygen . .	275 feet = 23·46432	175 feet oxygen . .	condensed into carbonic oxide.	350 feet =	26·12736
14·39577 dry charcoal. .	Carbon vapour. .	450 feet = 14·39577	350 feet carbon vapour			
			100 feet oxygen . .	condensed into carbonic acid. .	100 feet =	11·73273
			100 feet carbon vapour			
40·79154 Total materials consumed.				Total gas	1000 feet =	40·79154

Water gas in this state is, however, unfit for use until it is deprived of its 100 feet of carbonic acid, either by lime or some other material similarly acted upon, in which case the bulk of the remaining gases is reduced to 900 feet; or by again passing the entire gas over highly heated carbon, the total volume will be increased to the extent of 100 feet by the conversion of the 100 feet of carbonic acid into 200 feet of carbonic oxide, in consequence of the absorption of an additional quantity of carbon vapour by the latter. In this state the mixed gases consist of equal volumes of hydrogen and carbonic oxide, and their constitution will be clearly indicated by the following table:—

lb.		lb.			lb.
23·99616 water. .	Hydrogen			500 feet =	2·66496
	Oxygen	250 feet = 21·33120	condensed into carbonic oxide . .	. .	500 feet =	37·32480
15·99360 dry charcoal. .	Carbon vapour . .	500 feet = 15·99360				
39·98976 Total materials consumed.			Total gas . .	. .	1000 feet =	39·98976

We thus learn that, theoretically (in round figures), 24lb. of water and 16lb. of dry charcoal (or carbon in some other form) combine to produce 1000 feet of such water gas as is intended to be subsequently prepared by the hydro-carbon process, for illuminating purposes. Practically, it has been found by experiments, to which we shall presently allude, that from 18lb. to 18½lb. of the charcoal of commerce, or 20lb. of good Newcastle gas coke, are required; the excess, doubtless, arising from the moisture contained in the charcoal and coke of commerce, and in some degree also to the loss from combustion which takes place during the operation of charging the retorts. Coke also contains a quantity of sulphur and earthy matter in combination with its carbon, which after a short time materially interfere with the disposition of the latter to enter into combination with the oxygen.

The only published experiments on the cost and manufacture of purified water gas with which we are acquainted, are to be found in a paper by M. Magnier, the engineer for Gillard's Water Gas Company, inserted in the French *Journal de l'Eclairage au Gaz* for May. They were conducted on a scale sufficiently large to produce 500 cubic metres, or 17,500 feet, in 24 hours; and, from the fact of their telling seriously against the interests of the company on whose behalf they were made, we are inclined to place confidence in their accuracy. M. Magnier consumed in the manufacture of 500 cubic metres, or 17,500 English feet, of water gas—143 kilogrammes of charcoal to decompose the water, 350 kilogrammes of coal as fuel for heating the retorts, 83 kilogrammes of coal for vaporising the water, and 390 kilogrammes of lime for purification. A kilogramme is 2·2lb.; and our readers will, therefore, see that each 1000 feet of purified gas was obtained at the expense of 18lb. of charcoal, 54·4lb. of fuel, and 49lb. of lime. The cost—exclusive of wear and tear, interest on capital, patent right, &c.—is set down at 7½ centimes per cubic metre, or within a fraction of 1s. 2d. per 1000 cubic feet.

Some unpublished experiments by Mr. Lewis Thompson, made at the suggestion of Messrs. Bachhoffner and Defries, corroborate M. Magnier's as to the consumption of charcoal. He found it to range from 18lb. to 18½lb. per 1000 feet; but, owing possibly to the imperfect construction of his furnace, the fuel with him considerably exceeded M. Magnier's ratio. Other experiments within our knowledge show that when Newcastle gas coke is used, and the process is carried on upon a large scale, 20lb. of coke in the retorts, and 60lb. as fuel, must be calculated upon as the minimum consumption. To produce water gas at Mr. Clegg's price for these items, we must consequently have Newcastle coke for fuel at 4s. 8d. per ton, and for decomposing water at 3s. 10$\frac{7}{10}$d. per ton.

Mr. Clegg estimates the repairs of retorts, mains, &c., at 2·458d. per 1000 feet, and the labour at ·625d.; together a trifle over 3d. The expense of purification is entirely omitted, though it is quite certain that all water gas manufactured in connection with coke, must contain a portion of sulphuretted hydrogen. His allowance for wear and tear is similar to what he sets down for the corresponding charges in the manufacture of coal gas. He is, perhaps, speculating upon the use of clay retorts in the manufacture of water gas; but he will soon find, as others have done who have already tried the experi-

ment, that their porous nature renders them totally inapplicable to the retention of such gases as are obtained by the decomposition of water and carbon. Metal retorts must consequently be used; and, when we take into consideration the high temperature at which they must be maintained to prevent, as far as practicable, the formation of carbonic acid, and that, unlike coal retorts in which a fissure may be temporarily stopped up by carbon, the water-gas retort, having once become faulty, cannot be similarly repaired; and it is quite clear that this item will exceed the average expenditure under this head in a coal-gas work. The allowance of ·625d. for labour is so palpably a miscalculation, that it would be a waste of time to attempt to show its insufficiency.

Mr. Clegg is evidently mystified with his subject, and has no very distinct idea of the process of water-gas manufacture. He attempts to make it appear that each 1000 feet of water gas, when generated in connection with cannel or coal gas, involves a less expenditure of money than when an equal volume of water gas is generated in a distinct apparatus specially adapted for the operation. He forgets that, in both cases, an equal weight of water must be decomposed, necessitating the expenditure of the same quantity of fuel, and that it is immaterial whether the carbon is abstracted from the coke in the water-decomposing retort, or from the coke in the cannel retort; certain fixed quantities of matter are consumed in either case; and the only question really open to discussion is, whether the manipulation, and wear and tear of apparatus, will be least when the combined system, or when the separate process of manufacture, is adopted. We are inclined to believe the separate system to be preferable, as it permits the engineer to construct his apparatus upon the best principle for effecting each operation—first the generating of water gas, and next the mixing it with carbonaceous substances while undergoing decomposition.

Our readers have now before them the materials for appreciating the cost of water gas in London, and judging of its capacity for being used with cannel coal in the manufacture of illuminating gas.

COST OF 1000 FEET OF WATER GAS IN LONDON.

	d.
1½ bushel, or 60 lb., of Newcastle coke as fuel, at 2½d. per bushel, or 11s. 8d. per ton	3·75
½ bushel, or 20 lb., of coke, for decomposing water	1·25
Labour	2·50
Wear and tear of retorts and apparatus	3·50
Purification	1·00
	12·00

That Mr. Clegg has also immensely exaggerated the extent to which cannel gases will bear dilution upon White's system, we have a remarkable and conclusive instance of in the experience at Southport. Mr. Clegg speculates upon Boghead cannel yielding 52,000 feet of 20-candle gas per ton. The Southport commissioners report that they are compelled to limit it to 34,000 feet; but the contrast between the theories of the one, and the realities of the other, are sufficiently instructive to warrant their introduction in juxtaposition here.

MR. CLEGG'S REPORT.

"BOGHEAD CANNEL.—This cannel, probably the richest gas material known, when treated by the hydro-carbon method, yields 52,000 cubic feet of 20-candle gas, and 75,000 cubic feet of 12-candle gas, per ton weight. There is little or no sulphur in its composition."

THE SOUTHPORT COMMISSIONERS' EXPERIENCE.

"Mr. Boothroyd inquired what was the general impression as to the gas made from the Boghead cannel.

"Mr. Cooper said that they had been informed by the patentees that they might get 40,000 feet of gas from a ton of the cannel, and they had during the last week succeeded in doing so, but the gas had not been so good as previously. If they satisfied themselves with making 34,000 feet per ton, they could make it as good as when Mr. White was in Southport. He had to say, however, that a lady had complained to him of a disagreeable smell of the gas in her dining-room, and he had himself perceived the smell in the same room.

"Mr. Boothroyd had reason to complain of the smell of the gas, which he considered very noxious, and had powerfully affected the females in the milliner's room at his establishment.

"Mr. Wood had taken notice of the deficiency of light during the previous week, when they were making 40,000 feet of gas per ton, but he believed that it would be sufficiently remunerative if they only made 34,000 feet per ton."

Mr. Clegg's assertions with regard to the extraordinary richness of this material, and its comparative freedom from sulphur, are undoubtedly true; but it is quite evident that these qualities are susceptible of being abused. The disagreeable smell alluded to by the speakers must have arisen from the presence in the gas of the small quantity of sulphur given out by the cannel, the carbonic acid having neutralized the action of the lime upon sulphuretted hydrogen.

On Mr. Clegg's calculations, 1000 feet of 20-candle gas from Boghead cannel and water, would have cost 1s. 0¾d., as follows:—

	Cubic feet.	d.	d.
Cannel gas	13·500 at	35·40 =	477·90
Water gas	38·500 at	5·00 =	192·50
	52·000		670·40, or 1s. 0¾d. per 1000 ft.

when, even admitting his estimate of the cost of Boghead gas to be correct, the figures should really have been:—

	Cubic feet.	d.	d.
Cannel gas	13·500 at	35·40 =	477·90
Water gas	20·500 at	12·50 =	246·00
	34·000		693·90, or 1s. 8$\frac{4}{10}$d. per 1000 ft.

The credit to which the following passage of the report is entitled may now be fairly judged of; and here, reserving many other points still to be noticed, we, for this month, leave the matter in our readers' hands.

"The cost of average London gas is about 1s. 8d. per 1000 feet; the saving, therefore, effected by making gas of the same standard of light from Lesmahago or Boghead cannel by the hydro-carbon process is 9½d. per 1000 feet—an amount which will cover the average charges for fuel, wear and tear of retorts, and would realise a saving of nearly £20,000 per annum to an average London company, with an annual consumption of 500,000,000 cubic feet; or equal to 7 per cent. on a capital sufficient to erect works and mains for a consumption of 500,000,000 per annum; or on the total consumption of London and its environs, which is about 5,000,000,000 cubic feet per annum, a yearly saving of £200,000."

The bill for amalgamating the Commercial and British Gas Companies has passed through the Commons, and will, in all probability, become a law during the present session of Parliament. The bill encountered some opposition from the local authorities of Limehouse parish, for whose protection the following clauses were introduced:—

"LXVIII. That the Commercial Company shall light, and are hereby required well and effectually to light, all public lamps in all streets and lanes, roads, squares, alleys, highways, and other public passages and places within the limits of this act, which they are from time to time required by any trustees, commissioners, or other persons having or exercising jurisdiction in or over any such streets, lanes, roads, squares, alleys, highways, and other public passages and places, to light.

"LXIX. Provided always, that the Commercial Company shall not charge any such trustees or commissioners, or any other persons liable to pay for such lighting, any sum exceeding the average sum which any six incorporated gas companies lighting public lamps within a radius of six miles from the General Post-office, in the City of London; to be named by such trustees, or commissioners, or other persons, shall charge for such lighting at per lamp, having regard to the time of burning, and the particular description of burner used for such lighting, or, in case less than six, then the average of the whole.

"LXX. Provided always, that the Commercial Company shall not be entitled to charge the trustees for executing the local acts of the twenty-ninth year of George the Second, Chapter LXXXVII., and the fifty-fourth year of George the Third, Chapter CXCIV., for lighting the public lamps lighted under the provisions of such acts or either of them, a larger amount for lighting such public lamps than they charge for lighting any other public lamps in any district under similar circumstances; and if the Commercial Company and such trustees shall not agree as to the price to be paid for any such lighting, then such price shall be settled by arbitration, under the provisions of the 'Lands Clauses Consolidation Act, 1845.'"

In a schedule attached to the draft bill we find a copy of the agreement made between a deputation from each party, when the terms were settled. The first rssolution is to the following effect, and is worthy of the consideration of other bodies similarly situated:—

"Resolved,—That it is doubtful whether the present reduced price of gas in the districts of the two companies can be maintained, and at the same time two capitals and two establishments worked at a profit; that, therefore, an union or amalgamation of the two companies, or the sale of the one to the other, is equally desirable for the public and the shareholders."

The *prestige* of the Great Central Gas Consumers' Company has received a severe blow from the loss of the public lighting in the district within which they compete with the Chartered Gas Company, and by which about one-tenth of their income, and one-ninth of the total quantity of gas sold by them, are struck off from their sources of revenue. This spirited movement is taken as indicating a determination to adopt a less timid policy than has been pursued of late, and as hastening the period when the whole question of the price of gas in the metropolis must undergo revision.

POSTSCRIPT.—Since the above was in type we have been

favoured with a paper by Dr. Fyfe, containing an elaborate series of experiments on the manufacture of hydro-carbon coal gas from Boghead cannel, the publication of which we must necessarily defer till next month. The conclusions to which the writer arrives are:—1. That cannel gases are susceptible of being diluted to a considerable extent with water gas.—2. That uniformity in the quality of the gas so produced is impossible with the apparatus now used.—3. That no increase in the quantity of light from a given quantity of coal is obtained by this process.—4. That the expense of diluting cannel gases with water gas exceeds the advantages derivable from the increase in the bulk, and that, consequently, there is no economy in the process.

Communicated Articles.

ON THE MOTION OF FLUIDS IN PIPES.

By William Pole, Esq., F.R.A.S.,
Associate of the Institution of Civil Engineers.

The object of the present article is to endeavour to elucidate the laws which govern the conveyance of fluids through pipes; a subject of such great practical importance that no apology is necessary for introducing it here.

There are three ways of treating questions of this nature.

The first is that of the mere mathematician, who propounds formulæ based on theoretical views only; but, since his speculations are unaided by experience, we cannot wonder that his formulæ often prove of very little practical utility.

The second is that of the uninformed practical man, who, finding a certain result produced in some known case, will vaguely infer that, therefore, a certain other result ought to follow under other given conditions; but, his inferences being unguided by principle, we need not be surprised that he should often be wrong also.

The third method consists in a combination of the other two, by which the faults of both are avoided. By this course we are enabled to test and correct the deductions of theory by the results of experience, and at the same time to render our experience available by the guidance of theory. It is this method we shall endeavour to follow in the present investigation: that is, we shall in the first place explain the general principles which govern the motion of fluids through pipes, and then, by combining these with the results of experiment, show how rules may be formed for use in actual practice.

General Principles.

Let us suppose a straight horizontal pipe, of uniform section and smooth bore throughout, to be open at one end, and supplied at the other end with a fluid under pressure; and let us further, in the first instance, suppose there to be *no friction* against the sides. The fluid will then pass along the pipe and issue from its open end with a certain velocity dependent on the pressure applied. Now, the laws of mechanics teach us that this velocity is the same as a heavy body acquires in falling from a height equal to that of such a column of the fluid in question as would produce the given pressure.

We may put this in a much clearer form algebraically.

Supposing all dimensions taken in feet, and all pressures in lbs., let p = pressure under which the fluid is supplied to the pipe, in lbs. per square foot.

S = weight of a cubic foot of the fluid in lbs.

Then the height of a column of the fluid which would produce a pressure, p, is evidently $= \frac{p}{S}$.

Also, let v = velocity of the fluid passing through and issuing from the pipe, in feet per second.

And g = the force of gravity = 32·19.

Then, since the velocity acquired by a body falling from a certain height is equal to the square root of the height multiplied by $\sqrt{2g}$, we have

$$v^2 = 2g\frac{p}{S} \qquad \text{(I.)}$$

which determines the velocity which will be produced by a given pressure; or,

$$p = \frac{S}{2g}v^2 \qquad \text{(II.)}$$

which determines the pressure for a given velocity.

We have now to consider the retarding effect of the *friction* of the fluid along the sides of the pipe. It is immaterial whether we introduce this by estimating the reduction of velocity under a constant pressure, or the additional pressure required to give the same velocity. We shall adopt the latter plan as most convenient in calculation.

The friction of fluids upon solids depends on laws altogether different from those which regulate the friction of solids upon each other. The former have not been so well investigated as the latter, but we may consider the following principles to be sufficiently well established for our present purpose.

1. The friction of a fluid upon a solid is independent of the hydrostatic pressure to which the fluid is subjected. Thus, the friction of water passing along a pipe, under a pressure of 100 lbs. per square inch, is no greater than if the pressure were only 1 lb.
2. It is proportional to the area of the rubbing surface. Thus, the friction of water in passing along a pipe 100 feet long, will be twice as great as if the pipe were only 50 feet long; or, if the circumference of a pipe be doubled (the length remaining the same), the friction will be doubled in like manner. If, therefore, l be made to represent the length of a pipe, and c its internal circumference, the friction will be proportional to $l\,c$.
3. It varies with the velocity, but in what exact ratio does not appear to be well determined. As a simple rule, however, near enough for practical purposes, the friction may be assumed to vary as the *square* of the mean velocity* with which the bodies move upon each other, or as v^2. Thus, if the velocity of water passing along a pipe be doubled, the friction will be increased fourfold, and so on.
4. It may also be assumed to be proportional to the specific gravity of the fluid, or will vary as S. The friction does not appear to be dependent in any other respect upon the nature of the two substances in contact, provided only that the fluid be in a state of perfect fluidity, and that the surface of the solid be so smooth as not to offer obstructions to the passage of the fluid along it.

Combining these laws, let f = the force necessary to overcome the friction caused by the passage of a fluid weighing S lbs. per cubic foot, with a velocity v, along a pipe whose length is l and circumference c. Also let M be some constant, to be hereafter determined by experiment, and which may be termed the *coefficient of friction*. Then

$$f = \mathrm{M}\,l\,c\,\mathrm{S}\,v^2. \qquad \text{(III.)}$$

Now, this force must be obtained by putting an additional pressure upon the fluid in the reservoir; let p' = the pressure thus added, in lbs. per square foot, and let the area of the pipe = a. Then the total additional force which this will give, tending to produce motion along the pipe, will be = $a\,p'$. But this must be equal to f, whence

$$a\,p' = \mathrm{M}\,l\,c\,\mathrm{S}\,v^2, \text{ or}$$

$$p' = \mathrm{M}\,l\frac{c}{a}\,\mathrm{S}\,v^2. \qquad \text{(IV.)}$$

If now we add this pressure to that before obtained (Equation II.), we shall have the total pressure at the supply end of the pipe. Let this, expressed in lbs. per square foot = P. Then

$$\mathrm{P} = p + p' = \frac{\mathrm{S}}{2g}v^2 + \mathrm{M}\,l\frac{c}{a}\mathrm{S}\,v^2; \text{ or}$$

$$\mathrm{P} = \left(\frac{1}{2g} + \mathrm{M}\,l\frac{c}{a}\right)\mathrm{S}\,v^2 \qquad \text{(V.)}$$

which is the general equation for the motion of a fluid in a pipe.

If the pipe be circular, and we put d for the internal diameter, then $c = \pi d$ (π being = 3·1416), and $a = \frac{1}{4}\pi d^2$; whence $\frac{c}{a} = \frac{4}{d}$; substituting this in the last equation, putting for g its known value, and reducing, we obtain

$$\mathrm{P} = \mathrm{S}\,v^2\left(4\,\mathrm{M}\frac{l}{d} + \cdot0156.\right) \qquad \text{(VI.)}$$

Data furnished by Experiment.

The last expression gives the relation which ought, according to general principles, to obtain between the quantities entering into the calculation, namely, the dimensions of the pipe, the pressure, and the velocity. This must now be compared with the results of experience, in order not only to test its applicability to practical uses, but also to determine a most important element of the calculation, namely, the *coefficient of friction*, M, whose value is still unknown, and respecting which theory gives us no information.

The manner of doing this is very simple. We have only to collect several good experiments, made under varying circumstances; to insert the given quantities in Equation VI., and then to deduce from these quantities, the value of the coefficient, M. If this value comes out nearly the same for each experiment, it will prove that the general equation is correct, and at the same time the value thus obtained will enable us to bring the rules into a convenient practical form.

For the present purpose we will take four experiments, each under very different circumstances, viz., two on water, one on air, and one on carburetted hydrogen gas.

* The particles of fluid in a pipe move faster at the centre than at the circumference; the *mean* velocity is such a velocity as, being multiplied into the area, will give the quantity passing through.

Dubuat has found that, in the case of water, the viscosity gives rise to an additional resistance, increasing as the simple power of the velocity, so that the friction varies as $v^2 + bv$, where b is a small constant. When the velocity is slow, as in rivers, &c., it is necessary to take this into account.

1. In an experiment at the Edinburgh Water Works, described by Smeaton in the third volume of his Reports, a pipe, 4½ inches diameter and 14,637 feet long, delivered water at the velocity of 1·815 feet per second, under the pressure of a column of water 51½ feet high. Here $P = 51{\cdot}5 \times 62{\cdot}5 = 3219$ lbs. per square foot; and $S = 62{\cdot}5$ lbs. Therefore

$$3219 = 62{\cdot}5 \times (1{\cdot}815)^2 \times \left(4\,M\,\frac{14637}{{\cdot}375} + {\cdot}0156\right)$$

from which M is found = ·0001.

2. In the "Transactions of the Institution of Civil Engineers," vol. 2, page 203, Mr. Provis gives an account of some experiments on the flow of water through pipes of 1½ inch diameter, and with varying lengths and pressures. We will take No. 4, where a 1½ inch pipe, 100 feet long, delivered 2 cubic feet per minute, under a head of 30 inches. Here the velocity will be 2·72 feet per second, and the pressure = 156 lbs. per square foot. Whence

$$156 = 62{\cdot}5 \times (2{\cdot}72)^2 \times \left(4\,M\,\frac{100}{{\cdot}125} + {\cdot}0156\right)$$

Here also M comes out = ·0001 nearly.

3. Some experiments made by M. Girard on the discharge of atmospheric air from a gasholder at one of the hospitals of Paris, are related in D'Aubuisson's "Hydraulique," Art. 525. The pressure was 0·002488 metres of mercury = 6·93 lbs. per square foot; the pipe was 0·01579 metres = 0·0518 feet, in diameter; and the length varied in the different experiments from about 6 to 128 metres. At 85·06 metres long, = 279 feet, the discharge was ·000409 cubic metres per second, giving a velocity of 6·86 feet per second. A cubic foot of air weighs ·0768 lbs.; therefore,

$$6{\cdot}93 = {\cdot}0768 \times (6{\cdot}86)^2 \times \left(4\,M\,\frac{279}{{\cdot}0518} + {\cdot}9156\right)$$

from which we have M = ·00009.

4. By an experiment at the Chartered Gas Works, Westminster, quoted by Mr. Hawksley in the Minutes of the Institution of Civil Engineers, 1845, page 283, it was found that under a pressure of 1 inch of water (= 5·2 lbs. per square foot) a main, 18 inches diameter and 1 mile long, delivered 66,000 cubic feet of coal gas per hour. The gas was of the density of $\frac{4}{10}$ that of the atmosphere, weighing ·0307 lbs. per cubic foot, and the velocity was 10·4 feet per second. Whence, according to the equation

$$5{\cdot}2 = {\cdot}0307 \times (10{\cdot}4)^2 \times \left(4\,M\,\frac{5280}{1{\cdot}5} + {\cdot}0156\right)$$

which gives M = ·00011.

It will be seen that these experiments give the value of M nearly similar in all cases, notwithstanding the great disparity in the circumstances; from which it may be fairly inferred that the principles upon which the formula is based are sound, and will apply in practice.

Deduction of Practical Rules.

It remains now to give the rules a convenient shape for practical use, and

(1.) *For Water.*

Refering back to Equation VI., and substituting for M its value above found, say ·0001, or $\frac{1}{10000}$,

$$\text{(VII.)} \qquad P = S\,v^2\left(\frac{l}{2500\,d} + {\cdot}0156\right)$$

But since it is generally the custom, in questions of the discharge of water through pipes, to estimate the pressure by the equivalent column, or, as it is called, the *head* of water, we may simplify the expression still more. Let h = the head in feet, then we shall have $P = h\,S$; whence,

$$\text{(VIII.)} \qquad h = v^2\left(\frac{l}{2500\,d} + {\cdot}0156\right)$$

or resolving the equation for the velocity, and reducing,

$$\text{(IX.)} \qquad v = 50\sqrt{\frac{h\,d}{l + 40\,d}}$$

These equations will give the velocity produced with a given head, or the head necessary to produce a given velocity; all the dimensions being in feet, and the velocity in feet per second.

It will be found, on tracing the progressive reduction of the equations, that the second term, 40 d, of the denominator in Formula IX., is derived from the force necessary to put the fluid in motion, or to give it velocity in starting from the reservoir. When the length of the pipe is as much as 400 or 500 times its diameter, this force becomes so small in proportion to the resistance from friction in the pipe, that it may be omitted altogether; which gives the exceedingly simple rule

$$\text{(X.)} \qquad v = 50\sqrt{\frac{h\,d}{l}}$$

The term representing this force must also be omitted if the effective head is measured by *pressure in the pipe*, instead of by the height of still water in a reservoir; as, the velocity in this case being already obtained, the force necessary to produce it must, of course, be excluded from the calculation.

It is often convenient to find the *quantity* of water discharged in a given time, independently of the velocity; and it is also very customary to measure the diameter of pipes in inches, and their length in yards:—

Let Q = quantity of water discharged per minute, in cubic feet.
d = diameter of pipe, in inches.
l = length, in yards.
h = head, in feet.

Then, making all the necessary reductions,

$$\text{(XI.)} \qquad Q = 2{\cdot}72\,d^2\sqrt{\frac{h\,d}{l + d}}$$

(2.) *For Gaseous Fluids.*

In order to adapt the rules to gaseous fluids, we may recur to Equation VII.

$$P = S\,v^2\left(\frac{l}{2500\,d} + {\cdot}0156\right)$$

in which, however, several alterations may be made. In the first place, the pressure under which gases work is generally measured by the height of an equivalent column of water, the gauges being constructed on this principle; if, therefore, h be made to represent the pressure in "*inches of water*," as it is termed, we have $P = 62{\cdot}5\frac{h}{12}$, or $h = \frac{P}{5{\cdot}2}$. Secondly, the density of gases is stated generally not by their weight per cubic foot, but by their specific gravity in reference to that of atmospheric air. Let s represent the specific gravity of a gas, air being 1. Then, since 1 cubic foot of air weighs ·0768 lb., $S = {\cdot}0768\,s$. Making these substitutions, and resolving the equation for v, we have

$$\text{(XII.)} \qquad v = 412\sqrt{\frac{h\,d}{s\,(l + 40\,d)}}$$

the dimensions of the pipe being in feet, and the velocity in feet per second.

But it will make the rule still more practical if it is altered so as to give the *quantity* of gas delivered in a given time, instead of the velocity, and also to put the dimensions of the pipe in the terms usually employed, namely, the length in yards, and the diameter in inches. Let, therefore,

Q = Quantity of gas passing per hour, in cubic feet.
l = length of pipe, in yards.
d = diameter of pipe, in inches.
h = pressure, in inches of water.
s = specific gravity of gas, that of atmospheric air being 1.

Then, after making all the necessary reductions,

$$\text{(XIII.)} \qquad Q = 1350\,d^2\sqrt{\frac{h\,d}{s\,(l + d)}}$$

Or, if the length of the pipe be above 400 or 500 times its diameter, or in any case if the pressure be measured in the pipe instead of in the gasholder,

$$\text{(XIV.)} \qquad Q = 1350\,d^2\sqrt{\frac{h\,d}{s\,l}}$$

Variation in the Position of the Pipe.

At the commencement of the investigation it was assumed that the pipe was perfectly horizontal; but, as this is not generally the case in practice, it is necessary to inquire what will be the effect of variations in its position.

The key to this will be found in the first general principle above enunciated in regard to friction; viz., that the friction is independent of the hydrostatic pressure to which the fluid is subjected. From this it necessarily follows that whatever position the pipe is made to assume, provided the other elements of the calculation remain the same, the friction will be the same also.

For example, suppose a water pipe leading from a reservoir descends to a considerable depth, and then rises again, the friction on the lower portions of the pipe will be no greater, length for length, than upon the higher ones, although in those parts the hydrostatic pressure will be, of course, much increased; and the friction of the whole pipe (setting aside for the present the obstructions caused by bends) will be no more than if it were expanded into one straight line between its two ends. Similarly, whether a pipe of a certain length be horizontal, vertical, or inclined, makes no difference whatever in the amount of the friction.

It is necessary, however, to observe, that when the two ends of the pipe are not at the same level, and the fluid passing through it is either heavier or lighter than atmospheric air, care must be taken to allow for this difference of level in estimating the motive pressure. For example, suppose a water pipe, leading out of a reservoir at a point 10 feet below its surface, to descend 15 feet before it discharges: here the effective head of water tending to force the fluid along the pipe is 10 + 15, or 25 feet. Similarly, if a gas pipe rise from a gasholder to a district lying 20 feet higher, and discharge there, the levity of a column of gas 20 feet in height must be added to the gasholder pressure in order to obtain the true motive force.

There is yet another consideration under this head which deserves notice. We have hitherto supposed the discharging end of the pipe to be open, or, which is the same thing, the pressure at that end to be = 0. This, however, is by no means necessary to the application

of the rules; for, if the discharging end is also under pressure, we have only to take the *difference* between the pressures at the two ends of the pipe, and to use this precisely as before.

The following rule will, therefore, serve universally, whatever be the position of the pipe, or the pressure to which the fluid is subjected.

From the pressure at the supply end of the pipe, deduct the pressure at the discharging end; then add or subtract, as the case may require, the gravitating influence of a column of the fluid equal in height to the difference of level (if any) of the two ends of the pipe: the result will be the true motive pressure or head, and may be used as such in the rules.

Disturbing Causes.

We have hitherto supposed the pipe to be straight, and free from any influences tending to check the passage of the fluid, except that of the friction along its sides. There are, however, in practice, other causes which affect the question; and, although most of them are scarcely capable of being reduced to rule, it is right they should be noticed here.

As a general principle, it may be remarked that all causes which tend to produce eddies, or disturbance of the particles of the fluid among each other, must inevitably check the velocity and diminish the discharge. Every particle of matter, once set in motion, tends to continue moving on in a straight line, and carries with it a certain amount of momentum, or *vis viva*, which it received at first starting. Whenever, therefore, the free forward motion of any portion of the fluid moving in a pipe is checked, a disturbance of the particles must take place among themselves, by which a portion of the *vis viva* is absorbed or destroyed, and a general diminution of velocity produced, which cannot be regained except by a fresh expenditure of moving power. Any one who will watch the course of an open stream of water, must soon observe the remarkable effect of eddies or disturbances in checking the velocity; and it must be obvious if the same causes are allowed to operate in closed pipes, where the velocity is generally much greater, the same results must follow in an increased degree.

The following may be particularised as some of the disturbing causes which affect the discharge of fluids through pipes:—

1. There may be some loss from the mode by which the water enters the pipe from the reservoir. If a round hole is made in the thin side of a tank (or what is termed on the Continent an "*orifice en mince paroi*"), the quantity of water flowing out will be only about $\frac{6}{10}$ of that due to the head and area, according to the rule embodied in Equations I. and II., this reduction being caused by what is called the contraction of the vein. If, now, a pipe or "ajutage" be fitted upon the hole, its length being about two or three times its diameter, the quantity will be increased to about $\frac{8}{10}$. If, again, the pipe be bell-mouthed towards the reservoir in a particular shape, the quantity will be increased to very nearly its theoretical amount.

Of course, therefore, the manner in which the entrance of the pipe is constructed must affect the quantity discharged; and, as this is often in practice complicated by the introduction of valves or sluices, it is impossible to reduce it to rule. It must be remarked, however, that, as this cause only affects the second term of the denominator in Equations IX., XI., and XII., it may be dismissed altogether if the pipe be of considerable length in proportion to its diameter.

2. *Bends* in the pipe have also a tendency to reduce the velocity, and, consequently, to lessen the discharge. It is evident that, if a sharp bend occur in a pipe in which a fluid is moving with considerable velocity, the particles, being suddenly diverted from the right line in which they naturally tend to move, will be caused to eddy, or become agitated among each other, and thus, as before explained, a portion of the *vis viva* will be absorbed, and the velocity to some extent reduced accordingly.

The investigation of the increased resistance arising from bends has been attempted by mathematicians, but with very little success. The ordinary formula, as used by English writers, is as follows:— If v = the velocity of the fluid in the pipe, ϕ = the angle of the bend, and h = the head of water necessary for overcoming the additional resistance caused by the bend; then

$$h = A\, v^2 \text{ Sin. } \phi,$$

where A is some constant.

It only requires, however, a very simple examination to show that this formula is, on the face of it, inapplicable and absurd.

In the first place, it is well known to all who have had to do with pipes, that, in ninety-nine cases out of a hundred the bends are not made sharp elbows, but are more or less curved; and it is a fact consistent alike with experience and with common sense, that, in proportion as the bend is curved with a larger radius, its disturbing effect upon the passage of the fluid becomes less in amount, until, if the curve be much expanded, the additional resistance may be said practically to vanish altogether. Now, the above formula contains no element whatever representing the radius of the bend; and, therefore, it would give the same resistance for a sharp elbow as for a curve of any radius whatever, no matter how large.

Secondly, it stands to reason that two bends of any given angle, placed together, should give double the resistance caused by one of them alone; at least it is difficult to imagine any reason why it should not be so; but this does not accord with the rule, according to which the resistance of a bend of 90° would be only 40 per cent. greater than one of 45°!

Thirdly, above a right angle, the sine *decreases* as the angle *increases;* so that by the rule, provided the bend be above 90°, the resistance would appear to become less as the bend becomes greater, until at 180°., *i. e.*, with a bend of a complete semicircle, it vanishes altogether!

It is certainly marvellous that a rule of such a preposterous nature, and producing such evidently absurd results, should for a moment have been received or promulgated. The fact is that the English writers on hydraulics, in copying from Dubuat, who established a rule for the resistance of bends, have misapplied a quantity which he termed the "*angle de réflexion*," by substituting for it the angle of the bend; and have thus misinterpreted his views, and introduced a rule altogether inappropriate to the case in point.* It could be easily shown that, by a correct application of Dubuat's principle to curved bends, a formula might be deduced which would be free from the defects of the one above named, and would appear to be reasonably applicable to the case in question; but as, unfortunately, we are not in a position to test it by experiment, we should be acting at variance with the principle on which we set out, to recommend it for use in practice. The few experiments which have been made upon the effect of bends do not appear to lead to any satisfactory result; and M. D'Aubuisson, whose researches on fluids are of great authority, was compelled to acknowledge that his attempts to establish a rule for them had all been in vain.

We are inclined to believe that in ordinary cases, if the bends are constructed with a radius tolerably large in proportion to the diameter of the pipe, the resistance is but of trifling amount; but that it may be considerable if the angle is sharp, and the velocity high.

3. Loss may also be occasioned by contraction or "throttling" in the pipe. If at any point in the length the aperture is diminished in area, the velocity must be increased at that point, which produces a corresponding increase of friction. Besides which, if the contraction be sudden, there is the additional loss by eddying and disturbance of the particles in entering the throttled part, and making their exit from it into the full bore of the pipe again. This last effect may be neutralised, if, where a contraction is necessary, the reduction in area be made gradually and smoothly, without any sharp or abrupt angles for the fluid to impinge against; for this purpose, in practice, "reducing pipes" of a conical shape are used. With this precaution the loss by occasional contraction is not considerable. M. D'Aubuisson found, by an experiment on the Toulouse Water Works, that a diminution of the pipe, in one place, of $\frac{94}{100}$ its area, produced only $\frac{1}{100}$ diminution in the quantity discharged.

4. It is singular, but not the less true, that *enlargements* of a pipe will often produce a greater loss than contractions. Venturi found that, by putting five large aneurisms on a tube, he diminished the discharge nearly 40 per cent. The cause of this is, of course, entirely due to the eddying of the fluid in the enlarged spaces, and the disturbance in the motion of the particles caused thereby. It may be diminished by adopting the precaution mentioned in the last case, namely, by making the alterations of form and dimension as smooth and gradual as possible.

5. There are many other causes of a minor kind which all, more or less, affect the discharge of a fluid through a pipe: such, for example, are irregularities of form of the pipe; accidental protuberances or vacuities; roughness of surface; sharp projections or cavities at the junctions, if imperfectly made; the peculiar form or arrangement of cocks, valves, or sluices; incrustations upon the internal surface of the metal; fixed deposits in the low parts of the pipe; leakage; or (in water works) collections of air in the upper parts; the pipe not running full; and so on. All these must have more or less influence on the velocity of the current, according to the degree in which they prevail in any particular case.

Now, since disturbing causes of the nature above described must exist to a greater or less extent, in almost every practical instance of the conveyance of fluids in pipes; and, since it is manifestly impossible to comprehend their effects in any method of calculation which shall be simple enough for general use, we must be content to adopt rules which will come tolerably near the truth when applied to practice. We cannot expect the results of experiment and calculation absolutely to coincide; but must rest satisfied if we find them approach within a reasonable limit of each other. Every prudent practical man knows the necessity of leaving a margin in his calculations for incidental or unforeseen disturbing causes, and therefore, in taking general approximate rules for his guide, he is enabled to arrive at a sufficiently accurate result.

And here it will be observed that the method of completing the formula by the aid of experiment has peculiar advantages in practical application; inasmuch as we introduce by that means the effect of the disturbing causes insensibly into the calculation. For, if the experiments are conducted on a sufficiently practical scale, they must of necessity be more or less affected by irregularities, and

* It is believed that this is the first time the mistake here alluded to has been pointed out.

any constant deduced from a mean of such experiments will, therefore, carry with it the mean effect of the disturbing causes which arise in practice. It is the business of the skilful and educated experimenter so to choose and regulate his experiments as to keep this end constantly in view.

There is another point of importance which is not always kept in view by the framers of formulæ—that is, that it is far better to make the rule *simple* (provided, of course, that its true principles are approximately maintained) than, by a complicated formula, to strive after an exactitude which we cannot, after all, hope to attain. The simple rule will often attract the practical man to its use, when the complicated one will frighten him away from it altogether. For the same reason it is desirable in coefficients to employ round numbers, if possible, instead of tiring the patience with a useless array of decimals. A rule with simple coefficients (take Equations X. and XIV. for examples), has the advantage of being not only very simple to work, but also easily committed to memory.

Comparison of the Formulæ with Experiment.

We have now only to show a comparison of the results of actual experiment with those given by the formulæ. It is much to be regretted that so few good experiments on this subject are to be found; for, although the results appear to agree tolerably well, yet it must be remembered that the constant coefficients in the equations have been deduced broadly from a very small collection of data; and it is, therefore, quite possible that more numerous and varied experiments may show that they ought to receive some degree of modification. For this reason we would invite the publication of any other experiments that may lie within the knowledge of our readers, as it is only by a comparison of a great number of these, obtained under widely differing circumstances, that the general applicability and correctness of the formulæ can be ensured.*

EXPERIMENTS ON WATER.

No.	Diameter of Pipe.	Length of Pipe.	Effective Head of Water.	Quantity actually discharged.	Quantity calculated by Equa. XI.	Difference per Cent.
	Inches.	Yards.	Feet.	Cubic feet per minute.	Cubic feet per minute.	
1	4·5	4879	44	9·6	11·	12½
2	..	4879	51·5	12·	11·9	1
3	..	4662	170·5	21·6	22·2	3
4	1·5	33·3	2·5	1·99	2.02	1½
5	..	26·6	5·05	3·36	3·2	5
6	..	20·	1·5	1·96	2·0	2
7	..	6·66	1·0	2·49	2·62	5
8	1·062	3·5	3·18	2·75	2·62	5
9	..	22·	2·1	0·94	0·95	1
10	..	17·8	1·06	0·73	0·74	1
11	1·41	10·7	2·13	2·77	2·68	4
12	..	42·8	..	1·38	1·40	2
13	..	64·	..	1·08	1·15	7
14	2·13	10·7	..	7·7	7·4	4
15	..	32·	..	4·68	4·53	3
16	..	64·	..	3·63	3·24	11
17	5·31	2500	2·2	4·3	5·2	17
18	19·1	1280	12·83	414·	430	6

Nos. 1, 2, and 3, are experiments tried upon the pipes of the Edinburgh Water Works, and recorded by Smeaton in the 3rd vol. of his Reports.

Nos. 4, 5, 6, and 7, are taken from the experiments of Mr. Provis, published in the "Transactions of the Institution of Civil Engineers," vol. ii. These experiments are upwards of 200 in number, but all with the same sized pipe. The great majority of them give results agreeing tolerably well with the formulæ.

Nos. 8 and 9 are by Dubuat, and Nos. 10 to 16 by the Abbé Bossut.

Nos. 17 and 18 are experiments tried by M. Couplet on the pipes of the Water Works at Versailles. In the former of these the head is so small in proportion to the length, that it is scarcely possible the pipe could have been kept full; and, consequently, the value of the result is doubtful.

We know other cases where the formula for water has been found to correspond well with experiment, but we are unable to state the particulars.

EXPERIMENTS ON ATMOSPHERIC AIR.

No.	Diameter of Pipe.	Length of Pipe.	Pressure in Inches of Water.	Quantity actually discharged.	Quantity calculated by Equa. XIII.	Difference per Cent.
	Inches.	Yards.		Cubic feet per hour.	Cubic feet per hour.	
1	0·62	7·2	1·34	183	170	7½
2	..	41·	..	73	74	1
3	..	62·	..	62	60	3
4	..	93·	..	52	49	6
5	..	119·	..	42	43·5	4
6	..	138·	..	39	40·2	3
7	..	141·	..	38·7	39·8	3

The above were tried by M. Girard in Paris, and are recorded in "D'Aubuisson's Hydraulique," Art. 525.

EXPERIMENTS ON COAL GAS.

No.	Diam. of Pipe.	Length of Pipe.	Pressure in Inches of Water.	Specific Gravity of Gas.	Quantity actually discharged.	Quantity calculated by Equa. XIII.	Difference per Cent.
	Inches.	Yards.		Air = 1.	Cubic feet per hour.	Cubic feet per hour.	
1	0·62	41	1·34	0·559	99	99	0
2	..	62	..	..	83	81	2
3	..	93	..	..	74	66	12
4	..	119	..	..	57	58	2
5	..	138	..	..	53	54	2
6	18·	1,760	1·	0·4	66,000	69,000	4½
7	4·	10,560	3·	0·4	852	1,140	25
8	0·5	10	1·25	0·4	120	129	7
9	..	59	..	..	60	55	8
10	10·	100	3·	0·4	120,000	112,000	7
11	..	1,760	3·	0·4	30,000	28,000	7
12	2·	25	0·5	0·528	1,630	1,440	11½
13	26·	3,130	0·8	0·42	103,000	114,000	10
14	..	4,300	2·25	..	175,000	166,000	6
15	..	..	0·475	..	80,000	76,000	5

Experiments 1 to 5 were tried in Paris, at the same works as those on atmospheric air, above cited.

No. 6 is the Westminster experiment, already alluded to.

No. 7 is recorded in "Clegg's Treatise on Gas Lighting." This is the only case in which the results of experiment and calculation differ considerably from each other. It must be noticed that the pipe is of a very great length (six miles) in proportion to its diameter; and it is, therefore, quite possible that the disturbing causes, spread over so great an extent, may have been more numerous and important than was supposed. At any rate, this is evidently an exceptional case.

Nos. 8 to 15 have been kindly communicated to the author by private friends, for the purpose of this paper.

* Since the above was set up for press we have been favoured with the particulars of a large and valuable collection of experiments on the discharge of coal gas through a main 9 inches diameter, and 1125 yards long, under varying pressures. We have not had time to reduce and tabulate them for the present number; but the results appear to be less by about 15 per cent., on an average, than given by the formula. This would require the constant 1350 to be reduced to about 1150; but it would not be judicious to adopt such an alteration for general use unless confirmed by other experiments on pipes of different dimensions.

For the benefit of such of our readers as may dislike the algebraical form of the rules, we may put Equation No. XIII. into words, as follows:—

1. Multiply the pressure by the diameter of the pipe, both in inches.
2. To the length of the main in yards, add the diameter in inches, and multiply the sum by the specific gravity of the gas. Divide the product by the result of (1), and extract the square root of the quotient.
3. Multiply the square of the diameter of the pipe, in inches, by the constant coefficient 1350, and divide by the result of (2). The quotient will be the quantity discharged, in cubic feet per hour.

The following shows Experiment No. 11 worked out in figures; as an example:—

1. $3 \times 10 = 30.$
2. $\sqrt{\frac{(1760 + 10) \times 0{\cdot}4}{30}} = \sqrt{23{\cdot}6} = 4{\cdot}86$
3. $\frac{100 \times 1350}{4{\cdot}86} = 28{,}000$ nearly.

THE PRICE OF GAS.

By J. O. N. Rutter, Esq.

Is the price of gas a test of CHEAPNESS? There is a growing necessity for an answer to this question; and it requires to be answered in such a way that all the parties interested might know why low-priced gas, and cheap gas, are not, necessarily, synonymous terms.

The business of a gas company consists essentially in manufacturing and selling LIGHT. Other products—as coke, and tar, and ammonia—are mere incidents in the process; being inseparable from present arrangements, of greater or less importance according to local or other circumstances, and (coke especially) constituting an important item in the cost of the primary element—gas. Difficult as it may appear to make the subject intelligible, there is no other means by which it can be properly understood, unless it be looked at, and attentively examined, in the way just indicated. Heat and light, generated by the combustion of fuel in the furnaces, are stored among, or around, the particles of hydrogen and carbon separated from the coal; and in that form conveyed to the burners. Whilst, therefore, gas is the vehicle, light is the material (if for my present purpose it might thus be designated) which is actually bargained for and sold. Hence it must be evident that, all other conditions being the same, of two samples of gas equal in

price and in quantity, that which contains, or rather from which can be obtained, the greatest quantity of light, is of most value to the purchaser, and consequently the cheapest.

The differences in the qualities, that is, the light-producing properties of coal-gas, are well known to the manufacturers, those of them, at least, who take sufficient interest in their occupation to make themselves acquainted with the first principles of the science. Such differences are chiefly due to the various kinds of coal in use at different parts of the kingdom, and partly to the management of the coal in the process of carbonization.

The differences thus referred to, as being entirely local, have been so far understood by the consumers of gas that dissatisfaction has not often been expressed, nor, excepting very rarely, has there been just occasion for any, on that account. Complaints about the price of gas is a totally different affair from complaints about its quality. "Gas of the best quality," although a conventional phrase, has always been understood to mean the best that could be produced from the coal in common use in the district. It would be as unreasonable for the consumers in Somersetshire to expect to be supplied with gas made from Lancashire or Scotch cannel, as it would be unjust in a London company to supply their customers with that made from the most inferior kinds of Welsh coal.

The value set upon light, and the desire to obtain as much of it as possible for the money expended in gas, is abundantly attested by the frequent changes in the forms of burners, and the skill and enterprise devoted to that branch of gas-fitting. Change of form is easy enough; not so, improvement: meaning thereby that kind of improvement which insures a greater quantity of light from a smaller consumption of gas. Still, the effort to economise is sufficiently apparent—another proof that the consumers of gas are not insensible to the difference between a good light and a bad one.

Until very lately, and for the reasons just now mentioned, the quality of gas was easily identified, because always associated with each of the coal districts. To the experienced manufacturer, the special characteristics of the gas in any particular locality were recognised, the moment the name of the place was mentioned. Changes are in progress. Why may we not expect them? In almost every department of art and manufactures, of science and commerce, there is an onward movement. In some of these the impulsive efforts seem to acquire accelerated force at remarkably short intervals. Gas-lighting has not stood still. Covering so large a surface, it is difficult to obtain a connected view of its vast operations. In all directions there are signs of extensions and enlargements. Hitherto the progress of gas-lighting has been more like a development of its own latent energies—the expansive force of a previously pent-up principle of action—than the strength put forth by any newly-acquired power originating in improved modes of manipulating. Much of this is due to the reductions which have been made in the price of gas. In some cases too long deferred, in no instance too hastily adopted, there is yet much to learn on a measure which has never been viewed through the right medium. How often have the teachings of experience been disregarded, and the warnings of previous mistakes forgotten! Gradually, although very slowly, we are getting nearer to the true commercial principle in the sale of gas. Would that it might never again be violated! There would then be some reason to hope that we should eventually establish data for determining its (local) value. This is necessary, in order to ascertain what might be considered a minimum price for any given place, as tested by the primary elements of manufacture in other places in the same coal district.

But we must be upon the watch, preparing for changes. There should be no faltering; no hesitating; no waiting to see what others will do. Let those largely interested in gas property and gas management look to it, that they miss no opportunity of making a good use of their power, their abilities, their money; by taking the initiative in every useful and duly-accredited improvement. There are secrets in nature yet to be revealed; materials unemployed, which for ages have been waiting to be pressed into our service; chemical combinations to be formed which a single thought might set in action; conditions to be observed, whose agencies may effect as much in an hour as can now be done in a day. Disentangling ourselves from old-fashioned prejudices, we must try to become proficients in the work of unlearning, and then acquiring will be so much the easier. Judging by what is in constant motion around us, have we not sufficient warrant for saying that, at any moment we know not how near we may be to some apparently simple suggestion, or, it may be, some elaborated improvement, either of which might require to be well pondered; and the effect of which might be to disarrange many of our present notions, turn the current of invention into other channels, and set us upon an entirely new tract, both of thought and of action?

Nothing is so much needed as a unity of purpose in gas-lighting—a means whereby every (so called) improvement could be fairly examined by competent and unprejudiced judges. Such men might thus be brought together, for purposes of scientific investigation, where the exercise of sincere and hearty co-operation need not in the slightest degree violate any feeling of personal or professional independence. Experiments, as such, do not, and cannot, effect all that is required. An experimental apparatus may be useful as far as it goes; and, as a first step, it may be a good instructor. Something more is required. There must be the opportunity of conforming to the hard necessities of every-day practice, not as a holiday exhibition of skill, of strength, and pleasant pastime; but with conditions sometimes in the worst possible plight, as a fair set-off against a little extra coaxing when everything goes on smoothly. A small station in London or its immediate vicinity—open to all parties, influenced by none—would afford the readiest means of working out results, in reference to some of the proposed improvements in gas making, which have so often presented themselves to thinking and practised men. The metropolitan gas companies, by their position and influence, could easily provide a small model-station, the advantages of which they would be the first to realize.

Let it not be forgotten that, whatever be the nature of the improvements, however apparently important the discoveries, how strange soever and unlikely the proposed changes, they have all to be weighed and measured, and otherwise tested, by pounds, shillings, and pence. This may be a tedious and a costly process; but, if they abide not the trial, we know what will be said of them. It is here that science and commerce seem to be antagonistic; for a time parting company, as if one or the other was in the wrong. The mistake is ours. Science is right, and commerce is right. We do wrong to both by trying to force them into an unnatural coalition. A vast amount of time, and patience, and money has been expended in these and similar investigations. The plan just mentioned, of a well-conducted model-station, would shorten the time of trial and lessen the expenses; and, by correcting mistakes and showing the cause of failure, it would effect as great an amount of good, on behalf of the science of gas-lighting, as by performing the pleasanter parts of its duties—helping inventors, by attesting the value of their improvements.

If it here be said, "What have these things to do with the question—Is the price of gas a test of cheapness?" I answer, just this:—Some of the recently-suggested improvements in gas making point most distinctly towards, what might be termed, an extemporaneous process, that is, a change in the quality at the pleasure of the manipulator. If that process, after fair trial, should ever be adopted, there will be greater necessity than ever that the quality, as well as the price, of gas should be accurately stated. The relation which quality and price bear to each other must also be understood, or we shall be getting farther off than ever from a commercial (gas) standard of value. Turning back for a moment to the definition with which I set out, that a gas company manufactures and sells light, it cannot be concealed that the light-producing properties of gas, according to locality, should be as uniformly alike as possible. Other conditions as to purity and means of supply must, of course, be considered, and, in their places, are equally important. Nothing occasions more dissatisfaction than occasional discrepancies in the consumption; and which are sometimes due to better, or worse, means of supply; and sometimes to the want of vigilance on the part of the consumers. If left unexplained, such trifling irregularities would be set down to a variableness of quality; and the extreme sensitiveness of the gas-consuming public on that subject deserves serious consideration.

It is not my intention, at present, to pursue this subject further. My purpose has been, not to offer any opinion on the statements recently put forth on the advantages of producing gas by a process different from that now in use. In summoning to my aid some of the thoughts, remembrances, and experiences of the last twenty years of my life, I have come to the conclusion that it should be matter for regret that so little has been done for improving the manufacture of gas; whilst there is abundant cause for congratulation in the increased consumption and methods of distribution.

Black Rock, June 4, 1852.

BILLOWS'S PHILOSOPHICAL GAS-TESTING BURNER.

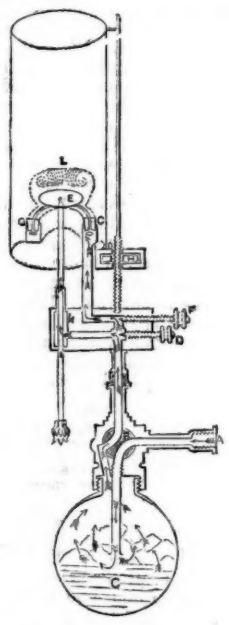
Such is the title given to an extremely interesting little instrument, invented by Mr. H. B. Billows, one of the inspectors to the Chartered Gas Company in London. Nor is this name altogether inappropriate; for, under certain conditions, a very correct idea may be gathered as to the quality of a given sample of gas by a few minutes' inspection of the effects resulting from its combustion in this apparatus. The richer or more carboniferous the gas operated upon, the greater the effect produced; and hence, therefore, when one uniform rate of consumption, or the production of some given effect, is implied, this burner becomes a testing instrument of no small value. It is chiefly, however, as an illustrator of the physiology of flame that this elegant invention deserves to be known; and to those who have not yet thoroughly appreciated the beautiful deductions of Sir H. Davy upon the cause of luminosity in flame, Mr. Billows has rendered an essential service by bringing the subject within the grasp of their optical faculties. "The philosophical gas-testing burner" gives, in fact, a synthetical demonstration of that which the vast reflective powers of Sir H. Davy enabled him to detect analytically almost forty years ago, and which, like the motion of the earth, has continued, since the period of its discovery up to the present time, a matter of faith with the million rather than of conviction. Mr. Billows has done for the one what M. Foucault has done for the other of these phenomena; and both are now sus-

ceptible of positive or physical proof. Want of space prevents us from giving so detailed a description in explanation of the "modus operandi" of this extremely interesting invention as it merits; nevertheless, we hope to render ourselves and the subject intelligible to the great bulk of our readers.

In an ordinary argand burner the gas, upon issuing, takes the form of a cylinder or tube, having atmospheric oxygen both within and without, by which means the particles of carbon are burnt or consumed as fast as they are thrown out of combination with the hydrogen by the action of the heat; and, if a larger quantity of gas be employed than can be consumed by the oxygen present, then particles of carbon are formed and escape as fast as they are produced in the shape of smoke or soot. But by the gas-testing instrument of Mr. Billows the outer surface of the gaseous cylinder only is exposed to the action of oxygen, and, consequently, the inner surface continues to evolve solid particles of carbon in abundance. Nor is this all; for, by means of a small central jet of gas, the air is drawn from the inner surface of the gaseous cylinder over the top and into the interior, so as to give a gyratory motion to the flame, and form, as it were, a hollow ring, revolving continually round its own circumference, and heated red hot. Now, it is within this ring that decomposition of the gas takes place; and the solid particles of carbon here deposited, having no available exit, revolve perpetually, and, coming into contact with each other, gradually cohere and assume the form of little stars or diamonds of exquisite beauty, until, becoming heavier and heavier by each addition of matter, they at length fall under the influence of gravitation to that part of the cylindrical ring where combustion is going on, when they are immediately caught up and projected into the air like a planet thrown out of its orbit, being followed, of course, by others in endless succession.

Hence we see that the action of the "test burner" is, in the first place, to cause a deposition of the carbon of the gas, and then to induce the carbonaceous particles to gather themselves into little spheres by a kind of centripetal power, each sphere revolving at the same time within the hollow ring of flame, so as to assume a distinctly centrifugal motion. The appearances thus produced seem to corroborate very strongly the well-known views of Col. Reid upon the law of storms; for the annular gyrations observable in the gas when burning can be described in no better way than by referring to Col. Reid's remarks upon the aerial currents which he conceives to be produced in the atmosphere by radiation and rarefaction. The test burner of Mr. Billows possesses, therefore, an additional value in this respect; and we are told that its exhibition at the late "conversazione" of the Society of Civil Engineers excited much interest, and attracted the marked attention of Lord Rosse, Messrs. Maudsley and Field, and other eminent savans. In fact, the noble and talented President of the Royal Society has, we believe, requested Mr. Billows to display his invention at an early meeting of that society.

Mr. Billows is also the inventor of an asbestos gas stove, which possesses many novel and pleasing peculiarities. These, however, as well as the action of the test burner, require to be seen to be appreciated. We merely, therefore, refer our readers to the drawings and descriptions of the test burner, politely furnished to us by Mr. Billows himself for this purpose.



A shows the ingress passage for gas to the burner.
B is a section of a plug of a four-way cock, which directs the gas through a glass bottle, C, containing any of the hydro-carbons or purifying compounds. By reversing the cock, B, the gas is allowed to pass free of the vessel, C.
D is a conical-pointed screw for regulating the flow of gas to the jet in the centre of the disc, E.
F is a similar screw for regulating the flow of gas to the circular jet, G.
H is a screw attached to the glass-holder for regulating the flow of air by elevating or lowering the chimney glass.
I is a small tube passing through a small chamber, K, to allow a continuation in the supply of gas, whilst the disc, E, is left free to be raised or lowered,
L is one of the forms assumed by the atoms of carbon deposited.

The mode of operating is as follows:—Adjust the disc, E, to about a quarter of an inch above the outer ring; turn the screw, F, so as allow the gas to burn with a low blue light; then permit a small quantity of gas to issue through the centre jet in the disc by turning the screw, D; the vapour of carbon contained in the gas becomes immediately solidified, and puts on the appearance of little balls of fire, which revolve round and round continually, and are very beautiful.

By the combined adjustment of the screws, this burner is capable of giving the maximum or minimum quantity of light of any gas used for light-giving purposes. It might, therefore, form a standard for experimental purposes.

OBSERVATIONS ON THE FIRST REPORT OF THE CHEMICAL REFEREE ON THE QUALITY OF THE GAS SUPPLIED BY THE GREAT CENTRAL GAS CONSUMERS' COMPANY.

By Lewis Thompson, Esq.

I remember to have heard of an artist who was in the habit of writing the words, "this is a horse," "this is a ship," and so forth, beneath the various productions of his pencil, by which means he not only anticipated, but also answered, the incipient inquiries of the spectator. The idea was a happy one under the circumstances; and I am glad to perceive that the chemical referee, in his first report to the Honourable Commissioners of Sewers of the City of London, has thought proper to adopt the same comprehensive system.

Dr. Letheby begins by telling the commissioners that he presents them with a report upon "the illuminating power and chemical quality of the gas" supplied by the Great Central Company to the City of London; and truly, without some such notification, the commissioners might, as Hamlet says, "have burst in ignorance" ere they discovered the value of the said gas from the report of their referee.

To criticise such a production would be a work of supererogation; for it contains within itself the bitterest of critiques, unless indeed we are to regard it as an affair got up merely "per jocum vel ad captandum vulgus." For my own part, I should no more expect to find out the illuminating power of the Central gas by dissecting this report, than I should hope to discover the phrenic nerve of a pulmonary hydatid, or the composition of the *elixir vitæ*. It realises, however, the pre-Adamite conception of the Roman poet, "cruda indigestaque moles quam dixere chaos," and reminds me of a practice ascribed to Chinese physicians, who, being consulted in a dangerous case, prescribe a little of every medicament they are acquainted with, in the hope that some of them may suit the complaint. Similarly, those of the commissioners who desired it might have any kind of gas they thought proper, from 13 candles to 22·2—it was all one to the chemical referee.

> "Seest thou yon cloud? 'tis like a camel, is't not?
> Ay, 'tis like a camel.
> And yet, again, methinks 'tis like a whale.
> A whale! Yes, 'tis *very* like a whale."

But it seems to me that great injustice has been done to the engineer of the Central Gas Company by this report; and although I am so ignorant concerning that gentleman, as not to know him when I see him, and have never heard the name of Mr. Croll except in connection with his present position, and with certain unchemical patents, about which my remarks, like their utility, shall be *nil*, yet I am told, in the first place, that Mr. Croll derives his origin north of the Tweed; and, secondly, that he held for some time a subordinate situation under Mr. George Lowe. Now, the inference I draw from these data is, that (except, perhaps, the renewal of a bill "more Scotico") Mr. Croll was not likely, from his national characteristics, to give more of anything than was legally due; and, therefore, the gratuitous extravagance of 22 candles instead of 12, is far from probable. Again, however, Mr. Croll, unless "duller than the fat weed that eats itself asleep on Lethe's wharf," must surely have learnt to do better than this under so distinguished a master. What! not know how to make gas of less illuminating power than 22 candles! I rush to the rescue. Mr. Croll's talent lies in an opposite direction. "*It is important in gas making, that the same quality of gas should be produced always. It is as injurious to produce rich gas one day and poor gas another, as for a man to live very high one day and very low the next. * * * To vary the quality, is like a man living on bread and cheese one day and on turtle soup another.*" (*Vide* Mr. Croll's evidence at

the late Kingston trial.) The report is a slur upon that gentleman's skill, and I vehemently protest against it as such.

Indeed, I have made experiments which thoroughly vindicate Mr. Croll's character from this imputation, and show that the variation is not in the gas, but in the "standard candle." I apologize for using the word "standard," but it is in the report.

Having purchased some "standard candles" at one of the two places indicated by the chemical referee, I burnt, in the first instance, one of them against an ordinary sperm candle of six in the pound; and, in the second instance, the one half of one against the other half of the same wax or "standard candle." The results are below:—

Wax Candle against Sperm Candle.

Wax at first ..	=	1·2 of sperm.
in 5 minutes	=	·95
in 7 minutes	=	·80
in 10 minutes	=	·75
in 12 minutes	=	·60
in 17 minutes	=	·56
in 20 minutes	=	·56
in 25 minutes	=	·57

Wax burnt per hour, 154 grains. Sperm burnt per hour, 132 grains.

EXPERIMENT No. 2.—*Wax against Wax.*

Lower part of candle.		Upper part of same candle.
No. 1 in 10 minutes	=	1·25 of No. 2.
in 15 minutes	=	1·5 of No. 2.
in 20 minutes	=	1·75 of No. 2.
in 25 minutes	=	2· of No. 2.
in 30 minutes	=	1·5 of No. 2.
in 35 minutes	=	1·4 of No. 2.

Neither of these "standard candles" was snuffed or touched in any way. No. 1 burnt 147 grains per hour; No. 2 burnt 144 grains per hour. When, however, a standard wax candle of this kind is perfectly trimmed so as to give out its full complement of light, it invariably exceeds the luminosity of a spermaceti candle; and, tried by this means, the Central gas, so far from giving an average of 17 such candles, has never in any one instance reached as a maximum 12 candles in all my experiments.

Quitting the illuminated part of the report, with its tallow candle "rechauffé" from the labours of that talented and careful investigator, Mr. J. O. N. Rutter, of Brighton, I now come to what Dr. Letheby calls the second part of his duty. This, it would appear, consists in demonstrating that the Central gas contains no sulphuretted hydrogen nor ammonia; and, had the report stopped at this point, I should have allowed it to pass without notice. But, not content with performing this second part of his duty, Dr. Letheby steps aside to talk about the gas "formerly supplied by the metropolitan companies." Now, it strikes me that the citizens of London care no more about the gas "formerly supplied" by the London gas companies, than they do about the "train oil," which in the olden time supplied the City lamps.

As, however, the question of purity has been raised, I have not the slightest objection to discuss it as fully and completely as can be desired; and, though I do not attach much importance to the circumstance, yet as Dr. Letheby's observations, by his own admission, extend only to the year 1849, whereas I have been testing gas, both in London and elsewhere, since the year 1835, he must admit that at least I am an older observer than himself.

Well then, going back to the year 1849, I assert, in direct contradiction to what Dr. Letheby wishes his readers to infer, that none of the City companies in that year sent out gas contaminated with sulphuretted hydrogen—accidents excepted; and such an accident may happen to-morrow at any gas works in the kingdom. Practically, however, there was then no more sulphuretted hydrogen in the gas than there is now. Ammonia there certainly was; and, if I know anything upon this subject, a little ammonia is the very reverse of injurious. It has, indeed, been asserted by some theorist that ammonia when burnt in gas produces nitric acid; but this is a total mistake, for ammonia does no such thing. On the contrary, it merely forms carbonate of ammonia if the coal gas be chemically pure; but, if this happens to contain bisulphuret of carbon, then it combines with and neutralises the resulting sulphurous and sulphuric acid, and is really of essential benefit. If Dr. Letheby had wished to investigate the purity or impurity of the Central gas, he ought to have attended most minutely to the quantity of bisulphuret of carbon contained in it; for this is, after all, the only thing in ordinary coal gas worth calling an impurity. But it so happens that, though not one word is said in the report about bisulphuret of carbon, I have, nevertheless, examined both the City and Central gases repeatedly in this respect, and most of my visitors of late have seen a very handsome crop of needle-shaped crystals of the zanthate, or hydro-sulpho-carbonate of potash, made from the gas supplied to me by the Great Central Gas Consumers' Company. And either Dr. Letheby or any other person is at liberty to come and examine them, and learn the mode in which they are extracted from the gas; for I have no secrets. The City gas has given me a mere trace of the zanthate of potash; and this leads me to suspect that the heat employed by the engineers of that company is rather low, whilst I draw the opposite inference as regards the temperature used at the Great Central.

A very simple experiment serves to show the correctness of this principle. Let an iron tube, closed at one end, be partly filled with a mixture of coke dust and iron pyrites. On placing this in a furnace it will be observed that, so long as a mere cherry-red heat is employed, no bisulphuret of carbon makes its appearance, however long the heat be maintained; but, so soon as a white heat is applied, bisulphuret of carbon begins to be disengaged, and this continues until the heat again falls to a cherry red, when it ceases. Gas engineers, therefore, who use a high temperature, are more liable to the presence of this impurity than others; and Dr. Letheby will do well to recollect that "those who live in glass houses should not throw stones." I am no advocate of the old companies, but common justice compels me to declare that which I well know, viz., that the Central gas is *not* superior either in illuminating power or in purity to the gas supplied to the City of London, in the year 1849, by the City and Chartered Gas Companies. Dr. Letheby's assertions respecting the non-existence of atmospheric air in the Central gas are as inconclusive as his wax-candle experiments. Why was the specific gravity of the gas not appealed to, or a regular analysis of it made?

THE CHEMISTRY OF GAS LIGHTING.

Were it not that coal gas is beyond all doubt a modern production, we should feel inclined to say with Solomon, "There is nothing new under the sun;" and, indeed, if some enterprising Layard, working in the subsoil of Thebes, had happened to dig up a gasometer with street mains, meters, burners, and the whole paraphernalia of a London gas work, our surprise could only have equalled that with which we greeted the other day the appearance of a paper on the composition of those fluids to which the luminosity of gas is due. For months we have been working upon this subject, under an idea not only that the demonstrated existence of these fluids was new, but also that the high specific gravity of their vapours was unknown to the scientific world. The very reverse, however, is, or rather ought to be, the case, for these fluids have long ago been obtained in a separate state, and examined by M. Couerbe, a chemist of considerable repute.

Our experiments upon this matter have been conducted, as is well known to our readers, upon a kind of inferential system, the specific gravity of the vapour removed by bromine being deduced from the loss of weight incurred in the gas by the employment of that reagent. Our results in this way have been so surprising when operating upon the ordinary Newcastle coal gas, as to lead us to make many repetitions ere we were willing to believe that the vapours in this gas could have so high a specific gravity as three times that of atmospheric air. Such, however, was the only conclusion to be drawn by actual trial, and as the termination of a laborious investigation we had found for the specific gravity of the light, giving matter in Newcastle coal gas, a range varying from 2·80 to 3·3.

At this juncture, accident threw in our way the fifteenth volume of the "Annales des Mines," a work published in Paris in the year 1839. Now, at page 375 of this work, a paper will be found by M. Couerbe "on the composition of the liquid which is deposited by compression from gas." This liquid had been deposited from resin gas, but its properties are so perfectly analagous with those which result from the different kinds of coal gas, that we do not for one moment hesitate in adopting M. Couerbe's analyses in preference to our own deductions, and with pleasure award to him the merit which his labours deserve. Nor is it a little singular, as corroborating the value of these labours, that actual experiment has enabled us to obtain from the fluid, condensed by bromine, a volatile hydro-carbon, possessing all the physical and chemical properties of oil of turpentine. A fact which goes far to prove that the vegetable matter from which Newcastle coal was produced, must have been of a resinous nature, and not, therefore, the product of a very warm climate. Taking this, however, "quantum valeat," the analyses of M. Couerbe are of great interest, and bear out in a most satisfactory manner the great principle upon which our calculation of the value of coal gas has been based. At the same time they present an admirable lesson, in more than one instance, of the importance of direct experiments as a means of controlling the results of the most careful analysis. From the liquid obtained by compression, M. Couerbe appears to have extracted six fluids of different composition and quality, the nature of which are indicated in the following table, together with the calculated and real or experimental specific gravity of their vapours, air being = 1:—

		Density of Vapour.		
		Calculated.		Found.
Liquid No 1	C^4 H^4	1·763	....	2·000
2	C^5 H^4	2·385	....	2·254
3	C^6 H^4	2·806	....	2·802
4	C^7 H^4	3·230	....	3·340
5	C^8 H^4	3·660	....	3·765
6	C^{28} H^{22}	2·665	....	2·637

The first of these has a specific gravity about equal to the condensible matter in Wigan cannel and Ramsey's cannel, whilst the third and fourth resemble that from Pelaw, Pelton, and other Newcastle coals. No doubt a portion of fluid more elastic than any of these remained in the compressed gas of M. Couerbe, and this would

necessarily have a lower specific gravity, and thus come to resemble the condensible matter in Boghead cannel gas and in Lesmahago, which are about 1·22 and 1·80, respectively. It is, however, a very remarkable fact, that such valuable analytical investigations as these of M. Couerbe should have lain so long in obscurity, well calculated as they are to throw a flood of light upon the most mysterious and perplexing points in gas lighting. We now proceed with our practical table of the coals of the Newcastle coal field:—

Name of Coal.	Gas per Ton.	Illuminating Power.	Specific Gravity of Gas.	Condensation.
Pelton	11,000	14·0	·430	4·5
Do. cannel	11,500	18·5	·520	10·5
Leverson	10,800	12·5	·425	4·0
Do. cannel	11,600	18·0	·523	10·0
Washington	10,000	14·0	·430	5·0
Do. cannel	10,500	18·0	·500	10·5
Pelaw	11,000	12·75	·420	4·5
New Pelton	10,500	12·0	·415	4·75
Dean's Primrose	10,500	13·5	·430	5·0
Garesfield	10,500	11·5	·398	3·75
Gosforth	10,000	12·0	·402	4·0
West Hartley	10,500	12·5	·420	4·2
Hastings Hartley	10,300	12·5	·421	4·3
Blenkinsopp	9,700	14·0	·450	6·0

Correspondence.

MR. LEWIS THOMPSON ON THE ILLUMINATING POWER OF GAS IN THE METROPOLIS.

Sir,—In accordance with my previous declarations upon this subject, I again present the readers of the Journal of Gas Lighting, and the public at large, with a faithful monthly summary of the illuminating value of the coal gas supplied to the City of London by the different gas companies. Difficulties, of a character not to be overcome by any exertions of mine, have, as yet, prevented me from obtaining a regular supply of the gas manufactured by the Chartered Gas Company. In fact, between that company and the City Company there exists a conventional arrangement at variance with the object I now seek to accomplish. This arrangement will not, however, I have reason to hope, be considered binding in a case so purely exceptional as mine; and, therefore, I trust that, ere long, I shall be able to furnish a perfect record not only of the gases supplied to the City of London, but also of those furnished to the whole metropolis.

The intense excitement which my humble efforts have already produced in the public mind, convinces me that the great body of the people is now fully alive to the necessity for some controlling influence over the quality of an article which presents a wider field for the exercise of duplicity and bad management than any other form or kind of manufacture whatever. In almost every other case the public can form a pretty correct idea of the value of the article brought to market; but in coal gas there is something so pre-eminently elastic and gaseous—something so indefinite, so intangible—that the otherwise acute perspective faculties of business-men become completely mystified and placed in abeyance by it. Once let gas be, as the expression is, "laid on," and a kind of "Hobson's choice" arises immediately with respect to payment; for the bewildered consumer finds himself compelled to cash a periodical bill, the interpretation of which is about as unsatisfactory and unintelligible to him as the last importation of arrow-headed characters from Nineveh, or the particulars of an oath administered in a county court. He pays, in fact, with much the same feeling that a foreigner, ignorant of our coinage, offers his purse to a Jew broker in Whitechapel, that value may be taken "à discretion" for some trifling article of purchase. The continuance of such a system is, as honest Dogberry would say, "most tolerable and not to be endured." I am trying to remove the ignorance which supports it. But, admitting the necessity for a controlling power of the kind alluded to, it may very fairly be asked—To whom shall this power be confided? My answer is easy—To no one individual whatever. In order that the interests of honesty, truth, and justice may be served, this power, like that upon which our constitution is based, must rest in the hands of many. Nor is there any reason to fear that, in a matter so closely connected with the public weal, a scarcity will occur of individuals both able and willing to vindicate the cause of equity. On this account I have deemed it advisable to publish not only a general monthly average, but also a careful daily record, of the specific gravity, illuminating power, and rate of condensation of each respective gas; so that the results may be checked and corroborated, or contradicted by other observers, who, like myself, are in a perfectly independent and unfettered position as respects all the gas companies in the kingdom. I invite such to publish their conclusions monthly in the pages of the Journal of Gas Lighting, where I know they will find all due courtesy, and the most perfect impartiality.

I cannot conclude without referring to the kind interest which my labours have created in my favour. To those (and they have been many) by whom my humble photometrical establishment has been visited, I return my sincere thanks for their unanimous approbation; to others (almost equally numerous), who have so opportunely encouraged me by letters, I offer a similar tribute of gratitude; and both may rest assured of my perseverance in the cause of truth, for, without vanity in this matter, I can lay claim to the sublime declaration of Cicero: "Jurarem per Jovem deosque penates, me et ardere studio veri reperiendi, et ea sentire, quæ dicerem."

General or Monthly Average of the Gases supplied to the City of London by the Gas Companies mentioned, between the 10th of May and the 9th of June inclusive.

	Specific gravity.	Illuminating power.	Condensation per cent.	Heating power.
Central ..	404	12·24	4·23	2667
City	410	13·51	4·42	2823
Chartered	408	13·80	4·57	2858

The average of the Chartered is from eight observations only.

Daily Record of Observations upon the Gases mentioned below, the Specific Gravity being taken by means of an Air Pump and Flask with a delicate balance, the Condensation by Bromine, and the Illuminating Power by a Spermaceti Candle, burning about 120 grains per hour, but always reduced to this gravity by calculation.

	City Company.			Central Company.		
Date.	Specific gravity.	Illuminating power.	Condensation.	Specific gravity.	Illuminating power.	Condensation.
May 10	·413	14·2	4·9	·420	13·	4·8
11	·414	14·3	5·	·417	12·1	4·75
12	·405	13·	4·25	·420	11·4	4·75
13	·416	13·4	4·75	·412	11·5	3·8
14	·393	12·1	4·60	·407	11·8	4·
15	·393	12·	3·95	·397	12·	4·4
17	·425	13·2	4·75	·414	13·	4·1
18	·425	13·3	4·4	·416	13·1	4·2
19	·415	13·1	4·1	·396	11·	4·25
20	·412	12·75	4·2	·400	12·	4·2
21	·416	12·47	4·75	·409	12·	4·25
22	·401	12·5	4·3	·406	11·5	4·
24	·416	12·8	4·5	·401	11·8	4·
25	·402	12·75	4·2	·403	12·7	4·75
26	·414	13·2	4·5	.408	12·25	4·25
27	·403	12·7	4.4	·401	11·6	4·
28	·400	13·7	4·4	·400	13·7	4·4
29	·401	12·6	4·2	·406	12·6	4·2
31	·418	13·	4·4	·400	12·4	3·8
June 1	·420	13·1	4·5	·393	11·4	3·9
2	·404	14·	4·1	·386	11·8	3·7
3	·407	12·9	4·25	·394	12·5	4·
4	·400	13·2	4·4	·395	12·6	4·1
5	·405	13·6	4·2	·405	12·8	5·
7	·420	13·2	4·5	.408	12·1	4·1
8	·424	13·8	4·3	·407	13·	4·25
9	·418	14·	4·5	·398	12·8	4·2

Lewis Thompson.

No. 7 A, Pancras-lane, City, June 9, 1852.

THE BUNSEN PHOTOMETER.

Sir,—My attention having been drawn to the remarks on the "Bunsen Photometer" in your last Journal, I beg to observe that the improved photometer, described therein as invented by M. Burel (and, as it appears from your remarks, pirated from Mr. Church), is identically the same as the photometer which I improved and introduced to the public in 1848, a notice of which appears in your Journal for June 11, 1849.

Not having seen either, I know not whether M. Burel or Mr. Church has fixed the distance of the disc and candle at 10 inches, or at any other distance, or whether they have made the photometer as portable as mine is. I was not even aware of their existence.

Should you find, on investigation, that I was the first to introduce this improvement, or that my photometer has any peculiarity over those of M. Burel or Mr. Church, then you will do me the favour to notice the same in your next number.

My photometer was the only one in the Great Exhibition of 1851.

Thomas Edge.

Westminster, May 13, 1852.

Legal Intelligence.

VICE-CHANCELLOR'S COURT.

SATURDAY, MAY 22, 1852.

(Before Sir GEORGE TURNER.)

THE SHEFFIELD UNITED GAS COMPANY *v.* THE SHEFFIELD CONSUMERS' GAS COMPANY.

Sir W. PAGE WOOD, Q.C., with Mr. AMPHLETT, appeared for the plaintiffs; and Mr. DANIEL, with Mr. TERRELL and Mr. LOGIE, for the defendants.

The plaintiffs are a company incorporated by act of Parliament, and the defendants are a company registered under the 7 and 8 Vic., cap. 110. An injunction was prayed for to restrain the defendants from laying their pipes, on the ground that the plaintiffs were in legal possession of an easement under which they had laid pipes throughout the streets, roads, and highways of Sheffield; and that their property would sustain irreparable damage, and such as could not be compensated for by an action at law, if the defendants were permitted to disturb the ground for the purpose of laying other pipes. A mass of affidavits were filed on each side, of which the following are an abstract:—

The first affidavit of the United Gas Company is that of Mr. *E. Unwin*, its managing director. He states that when there were two companies in Sheffield, neither could lay or remove their pipes without damage to the pipes of the other; and that the provisions in the act of the new company to prevent damage to the works of the old company were quite inadequate to prevent this. He then goes on to state that a new company has now been formed, of which he annexes the prospectus. He alleges that the highways of the several townships of Sheffield are managed by boards, or surveyors, who have no power by law to authorise any party to break up the streets, to lay pipes, but the companies so empowered by act of Parliament. That the deed of the Consumers' Company provides that the directors may commence operations, though the whole capital has not been subscribed, and that they may indemnify the highway boards and surveyors for any damage they may cause to the streets in laying the pipes, and against any costs and damages they may be exposed to for nuisances and the non-repair of the streets. He believes that the Consumers' Company intend forthwith to commence their works. The Sheffield highway board consists of 16 persons, of whom 15 are shareholders of the Consumers' Company; the Ecclesall board of 15 persons, of whom 5 are so interested; the Brightside board of 9, of whom 6 are so interested. By far the greater proportion of the gas consumption in the borough is in these three townships. He believes these boards will give the Consumers' Company leave to break up the streets; that thereby the United Company will be largely damaged as ratepayers; that their mains and pipes will be disturbed and damaged by the laying down of others, which must often cross them, especially at the corners of the streets; that the sinking of the ground, after it has been broken up, will be likely to disturb the joints of the pipes, and so cause leakage; that, where gas escapes, it often discovers itself at a considerable distance from its source, making it difficult to find the leak; and this is especially difficult when there are the pipes of two companies, from either of which it may come; and that frequent mistakes arise by one company inserting its service-pipes into the mains of the other company. He adds, that the nature of the soil, in some parts of Sheffield, causes the iron pipes to become so soft that they may be cut with a knife. While they are undisturbed, they still answer their purpose; but, if once disturbed, they are destroyed, and must be renewed. The affidavit concludes by noticing the advertisement of the Consumers' Company for tenders to construct a gasometer at Neepsend.

Mr. *George Lowe*, C.E., F.R.S., engineer-in-chief to the Chartered Gas Company, London; Mr. *J. T. Leather*, engineer of the Sheffield Water Works Company; and Mr. *John Fowler*, jun., C.E., depose to the impossibility of another company laying its pipes in streets already occupied by the pipes of a water or gas company without injury to them; and that escapes of gas often contaminate the water in the pipes adjacent.

Mr. *George Richardson* and Mr. *John S. Stephens*, inspectors of the Imperial and City of London Companies, prove that they have known in practice great damage and inconvenience caused by the laying of the pipes of other companies, and that the damage is likely to be the greater if the work be done during the night.

The replies of the Consumers' Company are contained in the following affidavits:—

Mr. *Samuel Highfield*, proprietor of the Roodie Gas Works, Chester, declares that he has laid his pipes in that city with little inconvenience to the public, and with no damage to the pipes of the previously existing gas and water companies. He will be glad to contract to lay the pipes of the Consumers' Company. *W. Layland*, his foreman, confirms him.

Mr. *T. V. Barnard*, manager of the Deptford Gas Works, has laid the pipes of various companies in Lambeth, Bermondsey, and Deptford, &c., by permission of the local authorities, whose power was not disputed; and never knew of any injury being done to the pipes of other companies. He will undertake to lay pipes without injury, where two or three other companies have pipes. No injury would arise but from wilfulness or carelessness.

Mr. *S. F. Holmes*, assistant surveyor of the Ecclesall Highway Board, says there is no practical difficulty or danger in laying the pipes of the Consumers' Company, and, that if there were twice the number of pipes in the ground that there now are, a new set might be laid without danger or difficulty, it being purely a question of expense to the company last seeking to lay its pipes. To lay the pipes in the night would be more expensive to the company, but more convenient to the public.

Mr. *Thomas Bunce*, of Reading, late manager of the Union Gas Works, alleges that there a new company laid its pipes without injury to those already in existence.

Mr. *Sidney Harvey*, of Westminster, surveyor, superintended the laying of the mains of the Central Gas Consumers' Company in London, in the face of an enormous traffic, and with pipes already in the ground almost like lace-work. Yet the amount of claims for damage was only £160, and a less sum paid them. Some damage was caused by carelessness on the part of the men; but the greater part was wilful, the men being influenced by other companies. There were 1600 men employed in laying the pipes of that company, and they were laid in the night. The shares were now from 30 to 40 per cent. premium. He would be glad to undertake the works at Sheffield, and that there should be no injury but from wilfulness or carelessness. There was no difficulty in the matter; the mains of the Consumers' Company would not be appreciable.

Mr. *N. Defries*, of St. Martin's-lane, gas-meter maker, says there is no difficulty in laying the mains of a new company, without causing any mischief. In any street, 10 feet wide, there need be no interference.

Mr. *Samuel Clegg*, of Regent-square, London, gas engineer, contradicts the affidavits of Messrs. Leather and Lowe. He would lay pipes without causing any damage, but such as may arise from the carelessness or wilfulness of workmen.

Mr. *John Scoltock*, inspector of a London gas company, says he has had experience in laying pipes side by side without causing damage. Never heard the authority given by a local board for laying pipes disputed.

Thomas Rushby, of Sheffield, main and pipe layer, was employed by the new company in 1836, and had no difficulty in avoiding the pipes of the old company. After the amalgamation, in 1844, the mains of the old company were mostly taken up; and of late the pipes of the United Company had been laid under the footpaths, thus leaving the carriage-way open. Practically, there was more facility for laying pipes now than in 1836.

Mr. *Thomas Gatley* deposes that he is well acquainted with the state of public feeling in Sheffield, and alleges against the United Company the various charges of monopoly, harsh treatment of customers, bad gas, &c., which have been made by the Consumers' Company. He sets forth the proceedings on the subject in the Town Council, and believes there is no reason to apprehend inconvenience in laying the pipes of the Consumers' Company, and that the object of the objection is to prevent rivalry. Has no shares in the Consumers' Company.

Mr. *Robert Gascoyne*, plumber, is acquainted with the mains of the water and gas companies. There was no difficulty in getting at the water pipes when two gas companies had their mains in the streets. There is less difficulty now; and he would undertake to lay the Consumers' Company's pipes without injury to those of the United Gas or the Water Companies.

Mr. *G. H. Palmer*, engineer to the Consumers' Company, alleges his experience, and that there is no difficulty in the case. It is only a question of cost to the company last seeking to lay its pipes. Few towns offer the same facilities as Sheffield.

Mr. *W. H. Pywell*, assistant engineer to the Consumers' Company, deposes to his acquaintance with the London mains; and that the facilities in Sheffield for the supply of good and cheap gas are greater than in most other towns. There is no ground to fear injury in the lfiying of the pipes.

Mr. Alderman *Thomas E. Mycock* gives an account of the history of the gas companies in Sheffield since 1836; states the causes of dissatisfaction alleged with the present company, as contained in Mr. Gatley's affidavit, adding the complaints of the company having interfered in the fitting trade. He says the provision of the local act to receive tenders for the lighting of the lamps is nullified by there being only one company.

Mr. *Thomas Edge*, of Westminster, gas-meter manufacturer, alleges that, in laying pipes in London, no injury has been done to those of former companies; that new companies have often been opposed in Parliament on the ground of such apprehended injury, but in vain; and that he could lay pipes in Sheffield without injury, excepting such as might be caused by the carelessness of the men, which efficient superintendence would prevent.

Mr. *George Flintaff*, secretary of the Consumers' Company, says, that it consists of 12,000 £5 shares; that 1653 persons have taken 8421 shares; that 1000 of the shareholders have signed the deed, and that 1500 of them are consumers of gas; that in June, 1835, when the new gas company was before Parliament, the committee suggested a union with the old company, which was declined on the allegation that it would set aside the principle of competition; that there are in Sheffield 27,099 houses, of which only 2100 are lighted with gas; that there are 600 gas companies without acts of Parliament, acting under the general laws and the local authorities; that the Consumers' Company intends to apply to the highway boards for leave to lay their pipes, engaging to make good the streets; that the Sheffield Water Company existed without an act of Parliament for 100 years before 1830; that the Consumers' Company would comply with the regulations of the highway boards, and meant to lay their pipes during the night; that the pipes will have a distinguishing mark, that they may not be mistaken for those of the other company; that the streets in Sheffield are of the average width of those in the City of London; that Mr. Unwin, who gives the opinion that the pipes cannot be laid without injury to the existing pipes, is not an engineer.

Mr. *John Smith*, surveyor of the Sheffield Board, says there is no practical difficulty or danger about laying new mains; that when the new company was formed, in 1836, they generally laid their mains on each side the streets near the footpaths, those of the old company occupying the centre; that those of the old company have mostly been taken up, and of late the mains of the new company have been laid under the footpaths, and that practically the facilities are greater than in 1836; that to lay the mains in the night will be more convenient to the public, but more costly to the company.

To these affidavits the United Company have filed others in answer.

Mr. *T. G. Barlow*, consulting gas engineer, of London, states that he has had 25 years' experience in the erection of upwards of 40 gas works; and that the laying of the pipes of the Great Central Company of London caused great inconvenience, damage, and expense to the existing companies, by interfering with their pipes. At York, the laying down of the pipes of a new company had caused to the old company, in repairs and escapes, a loss of some hundreds a year. Pipes could not be laid by another company in many of the streets of Sheffield without injury to the existing pipes.

Mr. *J. Simpson*, of Great George-street, Westminster, one of the vice-presidents of the Institution of Civil Engineers, and who for 30 years has been principally connected professionally with waterwork companies, says in his affidavit that the mains of water companies are constantly damaged and the water contaminated by the gas which escapes from broken gas pipes or loose joints, and the companies with which he is connected (the Chelsea and Lambeth Water Works Companies) are constantly put to considerable expense in searching for such escapes, and in remedying such contamination; and that the various gas companies have been compelled to pay for the damage which they have caused and the expense to which the water companies have been put; but that, nevertheless, they still sustain considerable loss from the difficulty of bringing the damage home to the said gas companies. In one instance an expense of several hundred pounds was incurred in a continuous search to discover in what manner the water had become contaminated with gas, which search lasted about a year and a half before it could be ascertained. He says that, from personal knowledge of the town of Sheffield, it will be utterly impossible for the defendants to lay down mains and pipes in many of the streets and highways already occupied by the plaintiffs, without frequently doing great mischief and injury to the defendants' mains and pipes, and often, from the nature and frequency of such injury, the mischief could not conveniently, if at all, be compensated in damages. At the corners or ends of almost every street the mains and pipes laid down by the defendants would of necessity cross those of the plaintiffs, and throughout the length of a great many streets the defendants' mains would necessarily be laid nearly close alongside, and that there would be imminent risk of serious damage being done to the plaintiffs' mains and pipes, more particularly if the defendants should lay down their mains and pipes in the night time, and without notice to the plaintiffs or their officers; that, if the plaintiffs' mains and pipes were not even touched, the latter would in many instances be broken or have their joints loosened by the settlement of the ground after it had been disturbed; and that, under such circumstances, a considerable time would frequently elapse, and a great quantity of gas escape, before the breakage or leakage could be discovered; that such breakage or leakage would frequently be at a point at a considerable distance from where the escape of gas took place, and that the difficulty of discovering the point where the damage has occurred would be frequently increased by the gas not finding an outlet until it had reached some sewer or drain, along which it would pass until it came to an opening on the surface. The plaintiffs would thus be under the necessity of opening the ground at various places, and for considerable lengths, before they could find the leakage or breakage. The escaped gas would often find its way into the mains, and contaminate the water of the Sheffield Water Works Company, which in many places passes in pipes very near the plaintiffs' mains and pipes; and the plaintiffs would also be exposed to the risk of explosions of gas arising from such escapes, and to have to make good the damage caused thereby. Instances are known to deponent where the mains of a gas company have been mistaken for those of a water company, and *vice versâ*, and mains of the wrong company have been bored into, for the purpose of forming a connection therewith, before the mistake was discovered. Further, in some situations, gas mains and pipes are acted upon by the surrounding soil, and the iron becomes oxidised and softened, and deponent has seen mains and pipes in that state in Sheffield; and when they became thus oxidised, and the ground near to them is disturbed, it is necessary to lay down new mains and pipes; whereas, if the ground had been left undisturbed, this would not have been necessary.

Mr. *William Innes*, of Southwark, engineer of the Phœnix Company, mentioned cases in which one company had for years supplied gas from the mains of a rival company, without the mistake being detected. Attaching service pipes to the wrong mains was of frequent occurrence. He knew that gas companies had had to pay for the contamination of water in the pipes of water companies, owing to escapes.

Mr. *T. Collinson*, newspaper reporter, produced the report of Mr. Palmer, presented at a meeting of the Consumers' Company, in which he admitted that in the case of some companies the loss by leakages exceeded the income returned on the capital of the company, and expressed the opinion that the Consumers' Company would have no difficulty in fulfilling the promises of its prospectus.

Mr. *E. Unwin* denied the statements on the other side that the new company, in 1836, laid its mains on each side of the carriage-way of the streets. There was now less room than before, owing to the greater size and number of the gas and water pipes. From June, 1838, to March, 1822, the two companies charged 8s. 4d. per 1000, excepting for public lamps, and the minimum paid was 6s. 8d. A reduction was made on the amalgamation in 1844, and again in 1847, 1850, 1851, and 1852. The maximum was now 4s. 7d., and the minimum 3s. 1½d. There was no gas company when the Police Act was passed, and it could not, therefore, contemplate tenders by two companies. When the new gas company was formed, it never made any tender for the public lamps, and only supplied a few lamps where the old company had no mains. When the new company was commenced, the price of the public lamps was 30s. In 1838 it was raised to 37s. 6d., and in 1839 to 43s. 6d., and in 1843 to 46s. 6d. The United Company had never been paid more than 45s., and since 1847, 44s., which was 1s. below the price fixed by their act, though the lamps now consumed 25 per cent. more per lamp than before. He went on to deny that the company had acted arbitrarily. When complaints had been made of the meters, they had tested them, showing that the error was against the company and for the consumer; that they had not compelled incoming tenants to pay the debts of their predecessors, except where they took to the stock of their predecessors, on which the company might have distrained; that the powers of clause 136 had been used only three times, and then the justices decided that they had been properly used; that the committee of the Town Council, appointed in 1850, did not make complaints to the company, or seek information from them; that the resolution of February last, pledging the Town Council to support the Consumers' Company, received the votes of three aldermen and twenty councillors, of whom two aldermen and fourteen councillors were interested in the Consumers' Company; that seven aldermen and eight councillors voted against the motion, of whom only one was interested in the United Company. Mr. Unwin next cited the opinion of the committee of the Town Council on the case of the gas-fitters, giving the opinion, that before interfering with the trade they should have offered to buy the stock of fitters, and showed that, by advertisement and otherwise, in July, 1851, they gave notice that they were prepared to purchase the stock necessary to connect the mains with the meters, and had, in fact, purchased all that had been offered to them; that they had not sought to monopolise or obstruct the trade of the fitters; that the company had undertaken fitting in consequence of the complaints of the public, and that as much for the public convenience as their own advantage; that Alderman Mycock was announced as a director of the Consumers' Company; that the clauses in the act of the company to protect the streets were settled by the Town Clerk on the evidence of Mr. Lee, the then surveyor; that, when there were two separate companies, 100 accounts were pending between them of claims for damage to their respective pipes; that before the election of the highway boards, placards were put out, recommending the election of persons favourable to the Consumers' Company, and he had no doubt that had been done at the instigation of the defendants.

Mr. *Alfred King*, of the Liverpool United Gas Company, proved that before the union the rival companies caused much injury to one another's pipes. By the union, the number of pipes was diminished. The damage to the pipes of the United Company, by the Consumers' Company laying their pipes, would be of a permanent character.

Mr. *J. S. Stevens*, inspector of the City of London Company, had to watch the laying down the mains of the Great Central, and had a number of men employed night and day for the purpose. Had not yet been able to make an estimate of the amount of the damage, and denied that he had instigated any persons to create it. Had since found it necessary to increase the staff of men employed to detect and stop escapes.

Mr. *Thomas Hawksley*, C.E., of Nottingham: It was impossible to lay the pipes of a new company without causing great injury. Could not estimate the damage and loss.

J. Lovejoy and *R. Rowlands*, of Reading, deny the statement of Bunce, and say that the pipes of the old company at that place were much injured by the laying down of the new.

Mr. *John Gunson*, sub-engineer of the Sheffield Water Company, said that Rusby was only a labourer employed by the contractors for opening and filling in the ground; that Gascoyne only did the plumbing of the Water Company; that, when a street had been broken up, it sometimes required resetting three times before it was made good. The company paid double price for its pitching, since one pitching seldom served after a street had been opened. When gas escaped it frequently contaminated the water in the pipes.

Sir W. Page Wood stated that the plaintiffs had been empowered to lay down their works by two several acts of Parliament passed in 1818 and in 1837. They formerly consisted of two companies, which were united and incorporated by act of Parliament in 1844. Their works were protected by various clauses of the acts relating to the town of Sheffield. The defendants were a joint-stock company, registered under the statute for that purpose, but had no parliamentary powers or authorities.

The affidavits referred to above were then brought forward.

The Court rose before the case was concluded.

Monday, May 24.

Sir W. Page Wood continued his argument on behalf of the plaintiff, and was followed by Mr. Amphlett.

The Vice-Chancellor (without calling upon the defendants' counsel for a reply) said—My opinion really is, that the plaintiffs have not made out a sufficient case to call on this court for an injunction to the extent prayed by the bill. The scope and object of the injunction is to prevent anticipated mischief, which it is said will arise to the plaintiffs by the works of the Sheffield Gas Consumers' Company. Those works have not yet been proceeded with, and this application is for an injunction to restrain them from proceeding, and thereby stopping them altogether. Now, I take it that this court, before it interferes by injunction in a case of this description, ought to be perfectly satisfied that irreparable injury, or that that species of injury which would call for the interference of this court, will be the necessary consequence of the act done by the defendants; because the foundation of the jurisdiction of this court, in cases of this description, is the superadded equitable remedy to the legal remedy. There is, by law, given a remedy for any injury which may be done to the plaintiffs by the defendants, and, when this court is called on to interfere, it is on the ground that the remedy which the law gives is insufficient to redress the injury about to be done. It is clear, therefore, that the court ought to be perfectly satisfied, not merely that injury will be done, but injury which will not be adequately compensated by damages at law. Now, in order to test this question, suppose, in truth, the works of the Consumers' Company had been in operation, and it appeared that casual injury had from time to time

been done by the Gas Consumers' Company in the operation of their works, and that an application had then been made to this court for an injunction to restrain the Sheffield Gas Consumers' Company from proceeding with their works, on the ground of the injury which those works had been to the works of the Sheffield United Gas Company. In that state of circumstances, undoubtedly, it would require a strong case, even if the injury were done, to induce the interference of this court before there had been a trial at law establishing the right of the Sheffield United Gas Company against the Sheffield Gas Consumers' Company for the injury done. It must be a case of the nature, as I apprehend, of continual and recurring injury, fully and clearly established, which would induce this court to superadd its equitable remedy to the legal remedy which the parties have for the injury done to them. I think, therefore, it is incumbent upon the plaintiffs to make out the case as a necessary consequence of the acts done by the defendants of injury of that nature which this court would interfere to prevent if the acts had been done, and which would be the necessary consequence of the acts which are about to be done by the defendants. Now, how does the evidence stand in this case? I think there are at least twenty witnesses, who state on the part of the defendants that these works can be done by them without creating any injury, except, as it is said in the affidavit of Mr. Clegg, trivial or temporary injury, creating trivial or temporary damage. Now, an application to this court for an injunction founded upon such injury certainly could not be entertained; therefore the affidavit of Mr. Clegg and of the other witnesses in the same terms are very decisive in my view of the case against the granting of this injunction. I think it is the duty of the court to take care that these injunctions, which are, in truth, injunctions founded upon trespass, be not extended beyond what they have hitherto been. The court, I think, has gone quite far enough in granting injunctions in cases of trespass upon the ground of irreparable injury, and I think that these injunctions should not be extended to cases where there is mere trivial or temporary damage. I have myself known injunctions of this description upon trespass applied for and refused, on the express ground that the injury was not of that nature which would induce a Court of Equity to interfere. Now, it is said, and it is true, that this case does in some respects differ from the other cases which have been before the court, because the defendants in this case have no legal foundation for the acts they are about to do. But I think the answer to that argument is this, that the parties who are complaining of the acts to be done, are not the parties who have the legal right to controvert that question. If the parties who had the ownership of the adjoining soil were applying to this court for the injunction on the ground that these defendants were disturbing their soil, that would be another and different question. So, if the Attorney-General were coming here, on the ground of public rights, to restrain those parties from taking up the highway, I can conceive that would be also a case of a totally different description. But here the application is, in truth, no more than this: the plaintiffs in this case have an easement in the soil, and they are applying on the ground, not of any public right or private right in the soil which belongs to them, but upon the ground of injury done to them; and by that case alone can they entitle themselves to relief. Now, it is said that great injury will be done to this company, in the first place, because it is said it will be a great expense on account of the necessity of their watching the proceedings and works of the new company. Now, no doubt they must incur that expense, and be subjected to some inconvenience, as everybody who establishes a great work must necessarily be, to prevent injury being done; but in doing that they are only watching for their own interests, and I cannot interpose the extreme power of this court by injunction on the ground that they will incur expense in protecting the works which they themselves have created. Then, again, great injury is stated to be likely to occur from the loss of gas, and from the necessity of taking up and laying down the streets, and the damage which there must be to the water-pipes. The answer to that is, that this injury may turn out to be of such a description that they may hereafter call for the interference of the court. But to interfere on the ground that there will be an injury, without knowing the nature and extent of that injury (and upon these affidavits it is stated to be only trivial and temporary), would be carrying the power of the court beyond what it has been considered to have been carried, and beyond what, in my opinion, it ought to be carried. Now, with reference to the observations made on the legal right to break up the ground, I think the answer to that is, that this is a ground for interference on the part of the public. But the parties are coming here, as it appears to me, on the ground of private right. And with regard to the ground put by Sir William Wood, of the interference of this court in these cases, I apprehend the court generally in these cases does not universally interfere until the right has been established at law. The court does not interfere until there has been a right tried at law, if there be any legal question in dispute.

Sir W. PAGE WOOD: There is no legal question here.

The VICE-CHANCELLOR: I am quite aware of that, and the way that it bears on the argument is this: you are calling on me to interfere on the ground of a question that cannot be tried at law; when, if the question were ripe for trial at law, I should say that I should not interfere until it had been tried at law. That is the view I take of this argument. Upon all these grounds, and the view I have of this case, I am of opinion, without saying in the least degree that there may not be ultimately a case to call for the interference of this court, that I must refuse this motion.

Mr. DANIEL: With costs, I apprehend?

The VICE-CHANCELLOR: I think I must give the costs. You have the satisfaction, Sir William Wood, of knowing this, that you have applied to the court in time, and if they go on you may say you have not in the least degree encouraged them.

Sir W. PAGE WOOD: That is a difficulty we had.

COURT OF QUEEN'S BENCH.

MONDAY, MAY 10, 1852.

(Sittings at *Nisi Prius*, before Lord CAMPBELL.)

EDGE *v.* SIR A. HILLARY, BART.

Mr. HOGGINS, Q.C., and Mr. ROGERS, were counsel for the plaintiff; Mr. BRAMWELL, Q.C., and Mr. ASPLAND, for the defendants.

This was an action for goods sold and delivered, the amount claimed being £171. 7s. 6d. The defendant, by his pleas, did not dispute the delivery of the goods, but pleaded the delivery of a bill of exchange to the plaintiff for the amount before action brought, and which had been accepted by the plaintiff on account of the debt. In this case it appeared that the plaintiff is a manufacturer of gas-meters, living at Westminster, and the defendant, Sir A. Hillary, is a gas engineer. In the year 1851, he, being the patentee of processes for the manufacture of gas, entered into a contract with the Corporation of Newport, in the Isle of Wight, to light the town with gas. Some time prior to that he had bought goods from the plaintiff, amounting to £82, and had given his acceptance for that amount, the bill being due on February 1, 1852. In November he also bought of him gas-meters and other materials for the Newport Works, to the amount of £171. 7s. 6d.; and the defendant's account of the transaction was, that the contract was for a three months' account (three months' bill and 15 per cent. discount). When the £82 bill became due, on the 1st of February, 1852, it was not paid by the defendant. For this a clerk of the plaintiff was sent to the defendant to ask him for the amount, and also for payment of the £171. 7s. 6d. The defendant then offered to give his acceptance for £171. 7s. 6d., but the clerk pressed for some other security besides his own, as the first bill had been dishonoured; whereupon the defendant offered to give him the acceptance of a Mr. Kemp, whom he represented as a respectable person with large expectations, who should also give a guarantee to secure further dealings to the amount of £500. The clerk said he would take the security of Mr. Kemp, if approved by his master, and asked for a reference as to the respectability of Kemp, when the defendant referred him to Mr. Gladstone, of Liverpool. On the 6th of February the bill was given; but at the suggestion of the clerk of the plaintiff it was drawn by Kemp and accepted by the defendant, and endorsed by Kemp to the plaintiff at that time. The guarantee was also produced, but not signed by Kemp, as it was contended by the defendant, because the clerk said he wished to make inquiry as to the respectability of Kemp; but it was contended that the bill was taken absolutely. The plaintiff, on the other hand, contended that the bill was only taken on approval, to be returned if the inquiries as to Kemp did not turn out to be satisfactory. The bill was at three months' date, and consequently would not become due until the 9th of May. The inquiries as to Kemp did not turn out satisfactory; but the bill was not returned until the 26th of February, the dishonoured bill for £82 having been paid by the defendant on the 24th. The whole contest in the cause, which lasted many hours, was whether or not the bill was taken absolutely, or only conditionally as to the result of the inquiries into the responsibility of Kemp; for, if the bill were taken absolutely on account of the £171. 7s. 6d., the plaintiff had no right to commence the action (which was done in April) until after non-payment of the bill, should it be dishonoured.

For the defence, the defendant alone was called; and on the other side the clerks of the plaintiff were called.

The Jury, after a short deliberation, found for the defendant.

WESTMINSTER COUNTY COURT.

MAY 25 AND JUNE 1, 1852.

(Before FRANCIS BAYLY, Esq., Judge.)

THE IMPERIAL GAS COMPANY *v.* CHAUNTLER, CLARKE, COLE, TEMPLE, AND OTHERS.

These were actions brought by the Imperial Gas Light and Coke Company against Mr. Chauntler, of Lowndes-terrace, Knightsbridge; Mr. Clarke, of the Lowndes Arms, Lyall-place; Mr. Cole, of Eaton-place; and Mr. Temple, of Motcombe-street, and several other gas consumers who had relinquished the use of the gas of the Imperial Company, and adopted that of the Western Gas Company, without giving the notices as prescribed in the contracts signed by the parties with the Imperial Company.

The case, which excited very great interest, came on for hearing on the 25th ultimo: Mr. Cox, of the firm of Willoughby and Cox, appearing for the Imperial Company; and Mr. BARBER, the secretary of the Western Gas Light Company, as solicitor for several of the defendants.

After some preliminary statements, in which the amount of the sums claimed for, and minor details, were admitted, providing the judge held the contract to be good,

Mr. Cox, in opening the subject, observed that in all these cases, with one exception, which was by scale, these parties, the defendants, had been consumers of the Imperial Company's gas under contracts called "meter contracts," to burn certain lights by meter, subject to certain conditions with the company, which the defendants had endorsed by their signatures, the 8th condition being as follows:—

"Previous to gas being discontinued, a notice in writing must be given to the company, not less than three calendar months previous to the expiration of the then ensuing quarter, or payment of the charge to the end of such ensuing quarter be made; the amount to be estimated by the company, either according to the number of lights, or from the corresponding quarter's consumption."

Now, he (Mr. Cox) contended that, the defendants not having given a three months' notice prior to the adoption of the Western Company's gas instead of the Imperial, the latter company, the Imperial Company, were entitled to the amount they would have received if the defendants had gone on burning their gas to the end of the quarter next after that during which the gas was discontinued; whereas the defendants had paid into court only the amount owing

for the gas which they had actually consumed up to the period of their changing their supply from that of the Imperial to that of the Western Gas Company. Mr. Cox stated that the question had already been tried in the Bloomsbury County Court, and he read to the judge the judgment of Mr. Sergeant Heath, which was, that although the 8th condition might not be binding, and the amount recoverable under it, where the contract was to burn by scale, still the condition did properly apply to meter contracts; and, therefore, that on meter contracts, even under the above form, the company were entitled to recover.

Mr. *Northfield* and Mr. *Newsom* having been called, and proved the signatures of defendants to the contracts,

Mr. Barber said, in the first place, he begged to call the attention of the court to the arbitrary character of these proceedings against consumers for penalties for having adopted a better gas.

The Judge thought they had better not go into the question of the merits of the gas of the two companies, as it had nothing to do with the question.

Mr. Barber then said that the demands were exorbitant, and that the language of a condition so indefinite as the 8th condition, or what was called a contract, ought not to be strained to enable the plaintiffs to enforce it. He would contend that, no time being mentioned for the termination of the notice, any written notice was a sufficient compliance with the condition, as every such notice, if given at all, must be a notice given three months before the end of the then ensuing quarter—namely, a quarter which had not then begun. In fact, he argued that the contract was so vague that it was really not binding at all, and should, therefore, be construed most liberally for the defendants, who only signed these printed documents called contracts, when brought to them, as a matter of form. He also took an objection that the "contracts" were not valid, inasmuch as there was no stamp upon them, and that the contract had been varied by the company by an alteration in the price of their gas, a reduction having been made during the period from 6s. to 5s. per 1000 cubic feet.

Mr. *Chauntler*, on being called before the court, stated that he had given up burning the Imperial Company's gas, although he only paid 6s. per 1000, whilst the charge of the Western Company's gas was 8s. per 1000 feet, because the former was so impure. He would pay willingly three times the price for the latter that he did for the former.

Cross-examined.—He admitted that the Western Company had promised him, if he gave up the gas of the Imperial Company and took that of the Western Company, to indemnify him against all proceedings by the Imperial Company.

The case of the defendant Clarke had this peculiar feature, that the defendant had not wholly and entirely given up the gas of the Imperial Company. Out of 12 lights, whilst the defendant had had 11 lights supplied by the Western, he had retained one during the whole period up to which the notice expired, supplied from the mains of the Imperial Company.

Mr. Barber argued that, even if the contract were held good, there had been no breach of it in this instance, as a three months' notice had been given, and was acknowledged by the secretary, and one out of the 12 lights had been supplied from the Imperial Company's gas up to the expiration of the notice, so that the use of the Imperial Company's gas could not be said to have been discontinued.

Mr. Cox contended that the terms of the 8th condition of the contract equally applied to the 11 lights discontinued equally with the discontinuance of the whole, as the lights had been lighted by some one else; and that, therefore, the defendant was liable to the payment for them up to the end of the then next ensuing quarter, the same as if the Imperial Company had supplied the whole.

The other cases, which in the main points were similar to that of Chauntler, having been gone through,

The Learned Judge said he would adjourn his decision till the following Tuesday, the 1st instant, at eleven o'clock. At that hour and date his Honour delivered his judgment in the following terme:—In this case the Imperial Gas Company seek to recover from the defendants under a certain contract which has been signed by them, or, rather, under the 8th condition, which is that "Previous to gas being discontinued, a notice in writing must be given to the company, not less than three calendar months previous to the expiration of the then ensuing quarter, or payment of the charge to the end of such ensuing quarter be made; the amount to be estimated by the company, either according to the number of lights, or from the corresponding quarter's consumption." Now, I think that this condition is open to the criticism applied to it on the part of the defendants. Although the document in question is entitled and headed "Meter Contract," it is nothing but proposals as to the terms upon which the consumers shall burn the gas of the Imperial Company; moreover, it is entirely one sided; but, be that as it may, the signing of the document by the defendants is admitted, and the question is, at what time a notice is to be given—whether it is necessary that such notice should be given not less than three months before the expiration of the then ensuing quarter. The wording of the condition is certainly vague, but the words are to be taken in the sense in which they are meant. The document is not in the form of an agreement, but merely a proposal; we must be guided by this rule, that the words must be so construed as to give effect to their action and meaning. The defendants' construction gives no effect to the words, "not less than three calendar months previous to the expiration of the then next ensuing quarter." I think that the meaning of condition 8 must be taken in connection with conditions 9 and 10; and by doing so it appears that the meaning of the parties obviously was that the contract for supply and use of gas should remain in force until the expiration of the quarter next ensuing the period of giving the notice by the company or consumer, as the case may be, that the supply or use of the company's gas would be discontinued. The meaning of condition 8, therefore, is that the consumer shall be at liberty to discontinue the use of the company's gas upon the terms here specified (viz., payment according to the rates agreed on), until the expiration of the quarter next after notice shall have been given of his intention to discontinue the same. There is no reasonable doubt as to the meaning of the parties, although the terms used in the document are incorrect. For these reasons the plaintiffs are entitled to recover in each case for the respective amounts claimed.—Judgment entered for the plaintiffs.

Miscellaneous News.

DR. LETHEBY'S REPORT to the CITY COURT of SEWERS. May 11, 1852.

The usual weekly meeting of the Commissioners was held this day at the Guildhall—Mr. Deputy Peacock in the chair.

After the transaction of the ordinary routine business, the following report from Dr. Letheby, the chemist appointed by the Court of Common Council to test the illuminating power and chemical purity of the gas supplied by the Great Central Gas Consumers' Company, was read by Mr. Dawe, the chief clerk:—

"To the Hon. Commissioners of Sewers of the City of London.

"Gentlemen,—Nearly three months have elapsed since I had the honour of being elected to the office of Chemical Referee, under the act of the Great Central Gas Consumers' Company; and in accordance with the provisions of this act, and the instructions which I have received from the Court of Common Council, I beg leave to present you with my first report on the illuminating power and chemical quality of the gas supplied to the City of London by the aforesaid company.

"This court will, perhaps, remember that in the 23rd section of the company's act (14 and 15 Vic., c. 69) it is decreed, 'that all the gas supplied by the company shall be of such quality as to produce from an argand burner, having 15 holes and a 7-inch chimney, and consuming 5 cubic feet of gas per hour, a light equal in intensity to the light produced by 12 wax candles, of six in the pound, burning 120 grains per hour; and such gas shall be superior in purity to the gas in common use, supplied at or about the 7th day of December, 1849, by any of the companies who then lighted the City of London, or any part thereof, with gas.'

"From this it is clear that the duties which I am called on to perform are of a twofold nature, namely—first, to ascertain whether the illuminating power of the gas supplied by the company is equal to the standard laid down in the act; and, secondly, to determine whether the purity or chemical quality of the gas is or is not superior to that which was in common use in in the City of London at or about the 7th day of December, 1849.

"In order to determine the first of these points, I have, within the last three months, performed as many as 30 experiments on the illuminating power of the gas. These experiments have been conducted at various times during the day and night, and have always been made without the previous knowledge of the company, or of any of its officers. I ought also to state that, for the purpose of guarding against every source of fallacy and error, I have taken the precaution to trace the pipe which supplies the gas to my laboratory, to its origin in the company's main. I have had my experimental meters subjected to the most rigid examination by your inspector, Mr. Taunton. I have used the best means for procuring wax candles of known purity, by purchasing them at two of the most respectable houses in the City of London, namely, at Mr. Batty's, on Finsbury-pavement, and Messrs. Cowan, of Mansion-house-street. I have employed the most delicate photometers. And, finally, I have taken care to record the details of my experiments in a volume which I have designed expressly for the purpose. I trust, therefore, that the court will consider the following results to be as truthful and as complete as the circumstances of the case will permit:—

"Out of the 30 experiments alluded to, I find that on one occasion the illuminating power of the company's gas was as low as that of 13 standard wax candles; this, however, is one-twelfth higher than the intensity required by the act of Parliament. On every other occasion it was considerably above this point; and, in one instance, it had actually reached to the intensity of 22·2 standard candles. To take the mean of all my experiments, it may be said that the average illuminating power of the gas, when burnt according to the act of Parliament's directions, is equal to that of 17 wax candles, each burning at the rate of 120 grains per hour. From this it will be evident that the company have, during the last three months, supplied to the City of London a gas of nearly one-half greater illuminating power than that specified in their act of Parliament.

"Not content, however, with this mode of investigating the facts of the case, I have instituted another set of experiments, the results of which will enable the court to form an estimate of the relative value of this gas as compared with other common illuminating agents. When the gas is burnt according to the act of Parliament's directions, it gives a light equal to that of 23 mould candles, of six to the pound, each burning at the rate of 145 grains per hour; or to that of 18 common oil lamps, each burning the best sperm oil at the rate of 133 grains per hour; or to that of 2·5 argand lamps, burning the same oil, each at the rate of 450 grains per hour; or to that of 13 sperm candles, of six to the pound, each burning at the rate of 133 grains per hour; or to that of 15 composition candles, of six to the pound, each burning at the rate of 136 grains per hour.

"Now, if we make an inquiry into the relative cost of these illuminating agents, we shall find that the facts thereof may be expressed as follows:—

The company's gas	equal to	1
Sperm oil burnt in an argand	,,	8
Mould tallow candles of six to the lb.	,,	12
Sperm oil burnt in an open lamp	,,	17
Sperm candles of six to the lb.	,,	24
Composition candles of six to the lb.	,,	29
Wax candles of six to the lb.	,,	30

"In other words, by estimating the cost of the company's gas at 4s. per 1000 cubic feet, the price of mould candles at 6d. per lb., the value of sperm oil at 8s. per gallon, and the price of the wax, sperm, and composition candles at 2s. per lb., it may be said that 1s. worth of the company's gas will go as far in the production of light as 8s. worth of sperm oil burnt in an argand lamp, or 12s. worth of ordinary mould candles, or 17s. worth of sperm oil burnt in an open lamp, or 24s. worth of sperm candles, or 29s. worth of composition candles, or 30s. worth of wax candles.

"In concluding this part of my report, I take the opportunity of suggesting that, in my opinion, it is advisable to make an alteration in the present mode of estimating the luminosity of the gas, and that, instead of employing a wax candle as the standard of comparison, it would be better to make use of a sperm candle, which burns at the rate of 130 grains per hour; for I find that the illuminating power and consumption of wax are much affected by accidental and uncontrollable circumstances. The consequence

of this is, that the value of the light so produced is far from being a fixed or certain product; besides which, it is difficult, if not impossible, to obtain a commercial candle of the act of Parliament standard; for it will be found that, instead of burning at the rate of 120 grains per hour, their combustion is usually at the rate of from 170 to 180 grains. This difference complicates the results, and exposes them to the errors of false calculation.

"With regard to the second part of my duty, I beg leave to say that I have submitted the gas to very careful examination, with a view of detecting two of the common impurities of coal gas, namely, ammonia and sulphuretted hydrogen; but I find that it is particularly free from these deleterious compounds. In this respect the gas is purer than that which was formerly supplied by the metropolitan companies. I speak from my own experience in the matter; for it happened that I was officially engaged in the month of October, 1849, in testing the quality of of the gas supplied by two of the companies to the City of London; and I have no hesitation whatever in saying that the gas furnished at the present time by the Great Central Gas Consumers' Company is superior, both in purity and illuminating power, to that which I had the opportunity of examining three years ago. A report has obtained currency that the gas which is supplied by the present company is largely diluted with atmospheric air. Upon this point I would remark that, if such a condition of things actually existed, one of two consequences would infallibly result—either the gas would be reduced in illuminating power, or it would become explosive, and would not burn from the jets at all. That the former is not the case is evidenced by the results which I have just detailed; and that the latter is equally untrue, is proved by the experience of every consumer.

"In conclusion, I have the satisfaction of saying that the company have offered me every facility in the performance of my duties, and have given me unqualified power to purchase, at their expense, everything which I may require for experimental purposes. They have likewise placed at my disposal two rooms in their house in Coleman-street, one of which is fitted up in a very complete manner for photometrical experiments, and the other is to be fully stocked by Mr. Knight, of Foster-lane, with all the apparatus necessary for performing the most searching chemical investigations.—I have the honour to be, gentlemen, your faithful servant,

(Signed) "H. LETHEBY.

"*London Hospital, May* 10, 1852."

The court then proceeded to open the tenders received for public lights. Two tenders had been sent in, viz.—one from the Great Central Company, for the whole of the City lighting, at £3. 17s. 6d. for the batswing, and £2. 13s. for the three-jet burners; and the other from the Chartered Gas Company for the lights in their district, at £3. 12s. for the batswing, and £2. 10s. for the three-jet burners. No tender was put in by the City of London Gas Company. A supplementary tender was produced from the Great Central Company, offering to substitute batswing burners for three jets without any increase of price; and a proposal was consequently made to refer the question to a committee. A motion, by Mr. Deputy Lott, that the tender of the Chartered Company be accepted, was, however, seconded, and carried unanimously, by which about 1000 lights are handed over to them for twelve months, and nearly 1800 are retained by the City and Great Central Company conjointly.

WHITE'S HYDRO-CARBON GAS.

MEETING OF THE SOUTHPORT COMMISSIONERS, MAY 11.

GAS-LIGHTING COMMITTEE.

Mr. Hodgkinson was instructed to write to Messrs. White and Co., to inquire whether they were disposed to make an offer for the Boghead tar.

The Committee reported that they had received a number of tenders to complete a tank and gasholder, and for gas mains, and that the lowest tender received on Saturday, the 8th, was from Mr. James Bimson, of Wigan.

Mr. COOPER explained that they had received in all eleven tenders, the lowest being from Mr. Bimson, and the next lowest from Messrs. Gilkes, Worsdell, and Co., the firm that supplied those now in use. The lowest tender was £572, and the highest £940. Inquiry had been made, and Mr. Bimson had been found to be a highly respectable man, and likely to fulfil the contract in a satisfactory manner.

Mr. BOOTHROYD inquired what was the general impression as to the gas made from the Boghead cannel.

Mr. COOPER said that they had been informed by the patentees that they might get 40,000 feet of gas from a ton of the cannel, and they had during the last week succeeded in doing so, but the gas had not been so good as previously. If they satisfied themselves with making 34,000 feet per ton, they could make it as good as when Mr. White was in Southport. He had to say, however, that a lady had complained to him of a disagreeable smell of the gas in her dining-room, and he had himself perceived the smell in the same room.

Mr. BOOTHROYD had reason to complain of the smell of the gas, which he considered very noxious, and had powerfully affected the females in the milliners' room at his establishment.

Mr. WOOD had taken notice of the deficiency of light during the previous week, when they were making 40,000 feet of gas per ton, but he believed that it would be sufficiently remunerative if they only made 34,000 feet per ton. They had been used to good gas, and, consequently, the difference was soon perceived. He understood that other towns were satisfied with the quality when the greater quantity was produced. He had not noticed the smell mentioned by Mr. Cooper.

Some further remarks were made respecting the estimates, in the course of which

The CHAIRMAN announced that there were three letters—apparently tenders—which, having arrived too late, remained unopened. He wished to know what was to be done with them. They were aware of the place that one of them came from, and it would be returned unopened; but they had no such knowledge of the other two.

Various suggestions were made, but it was ultimately decided that the Chairman should open them, and, if he found them to be tenders, at once burn them without making known their contents. This, having been found to be the case, was accordingly done.

A resolution that the order for the tank, gasholder, and mains, be given to Mr. Bimson, was then passed; and the proceedings of the gas committee were then confirmed.—*Southport Visitor.*

GAS MATTERS IN MARYLEBONE.

At the meeting of the Vestry of St. Marylebone, held at the Court-house on the 15th ultimo—S. J. Stephens, Esq., Churchwarden, in the chair,

Mr. GREENWELL, the vestry clerk, brought up the following report from the committee appointed to investigate certain matters contained in a memorial, presented by Mr. M'Dowall and Mr. Smith, praying the vestry to permit experiments to be made at the Court-house with a newly invented vegetable oil gas.

"At the Court-house Gas Committee—present, Mr. Row, in the chair; Messrs. Hodges, M'Evily, D'Iffanger, sen., George Poland, and Swaine—

"Your committee report, with regard to the memorial, referred to them of Messrs. M'Dowall and Smith, to be allowed to exhibit the patented oil gas at the Court-house, that they recommend that the application be granted, provided the apparatus be not placed in the Court-house premises, and subject to a guarantee being given that no expense shall be borne by the vestry; and that the consent of the surveyor to the insurance company is obtained, so that the rate of insurance may not be increased.

(Signed) "WM. ROW, Chairman."

Mr. Row moved the adoption of the report. He thought that, if such a guarantee as that contained in the report were given, there could be no harm resulting from allowing the experiment to be tried, as it might ultimately prove of service to the gas consumers of Marylebone.

The motion having been seconded,

Mr. NICHOLAY said he should give his determined opposition to such a report. That Court-house was not at all a proper place to try experiments of this sort, and, if they did allow it, they might on some occasion find the Court-house blown about their ears. (Laughter.)

The report was negatived by a large majority, without a division.

Mr. GREENWELL then brought up and read the report of the committee appointed to consider the application of the Western Gas Company to lay down a pipe from their mains on the Westminster side of Oxford-street, to their office in Holles-street. It was as follows:—

"St. Marylebone, May 7, 1852.

"At the committee appointed to consider an application from the Western Gas Company to lay down a pipe to their office—present, Mr. Beacon, in the chair; Mr. George, Mr. M'Evily, and Mr. Hodges—

"Your committee report that they have considered the application from the directors of the Western Gas Company for permission to lay a pipe from the company's main at the Regent-circus to their office in Holles-street, Cavendish-square, in order that they may have a supply of their own gas, for the purpose of testing the lighting of those premises, and the occasional proving of meters, the company undertaking not to supply gas to any other consumer in the parish without the permission of the vestry; and your committee recommend that the application of the company be granted upon the company entering into a bond to indemnify the vestry against all losses arising from such pipe being laid down, and to remove the same when called on by the vestry, together with all other necessary restrictions. (Signed) "GEORGE BEACON, Chairman."

Mr. BEACON, in moving that this report be received and adopted, said he looked upon the Western Company as a very ill used company by that vestry. If the vestry had treated them fairly, not only would the consumers of Marylebone have had competition in gas, but there would have been a clear saving to them of at least £50,000 to £60,000. Now, what did this company ask? They merely asked permission to lay down a pipe from their own main at the Regent's-circus, to their own office, in order to be enabled to test their own gas. He thought nothing could be more reasonable; and, as the company were prepared to give guarantees to indemnify the vestry from any injury thereby, he thought they could not reasonably refuse the application. As to the superiority of the cannel-coal gas over any other, there could be no doubt; and his conviction was, that, had the vestry given the Western Company an opportunity of fairly coming into the parish, they would have greatly benefited the consumers.

Mr. HODGES seconded the adoption of the report.

Dr. RUSSELL was surprised at this renewed and side-winded attempt on the part of this Western Gas Company to get into the parish of Marylebone. He denied that the Western Company had been unfairly treated by the vestry; but they had, in fact, not dealt fairly by the vestry; for, when opportunities were afforded them for coming in and laying down their mains in the parish, they always made some excuse to get out of it, and now they wanted to get in by a side-wind. (Hear, and "No, no.,') What were the facts? Why, that under the provisions of Michael Angelo Taylor's Act, if they once admitted a company to lay down a pipe in a parish, then such company could carry their pipes through any part of the parish; and then what would be the position of the Vestry of St. Marylebone, if such a thing were done, with the Imperial Company? (Hear.) Their present contract with the Imperial Company was such that, if they admitted any other company to lay down a pipe in Marylebone, then the Imperial Company could compel the vestry to pay something like £3000 per year more for their gas than they would have to pay were they not to allow such a proceeding. He had no doubt whatever that, if the vestry adopted this report, it would be held to be a violation of the contract by the Imperial Company, and they would call upon the vestry to pay the penalty. For these reasons he should give the report his opposition.

After a few observations from Mr. CLEMENT GEORGE,

Mr. BEACON, in reply, contended that, the Western Company being prepared to guarantee the vestry from any losses, there was ample security against the parish being damaged by the contingencies referred to by Dr. Russell. He, therefore, called upon the vestry to adopt the report.

On the question being put, the motion for adopting the report was negatived.

Mr. BEACON demanded a division, when the numbers appeared—

For the motion for the adoption of the report ..	12
Against it	36
Majority against the report	24

This portion of the business then terminated.

GIESSEN DIPLOMAS.—As the Doctor's degree, from the University of Giessen, is now obtained by so many undeserving persons, and is getting into such disrepute, we are bound, on account of the respect we entertain for some of its professors, to bring the matter before the public. Many students in this country who have gone up for the examination of M.D., and who, on account of their stupidity, have been rejected over and over again, fly, *as a last resort*, to Jena or Giessen, pay 180 florins (£15—the German universities are so poor that sometimes they will sell a degree *for a few pounds*), and return with the title of Doctor, with which they are as much tickled as a child is when it first gets a watch. The *Lancet* exposed the system of German M.D.-ism some years ago, and did much good. If anything, *the system of getting Ph. D. is just as gross and objectionable.* Some of our first men in England have studied at Giessen, and have had the degree of Doctor of Philosophy conferred upon them. Such men confer honour on the degree; but when the Ph. D. (like a knighthood) is awarded to tallow-chandlers, retail druggists, and other small shopkeepers, the case is different. We have received the following letter from Paris upon the subject of the Giessen diploma:—"I have known the *biggest fools* to have obtained a Ph. D.; but then they never get No. 1, generally No. 3—*i. e.*, the lowest possible. You must know that, if a person undergoes an examination, he obtains a diploma, stating whether he has passed it, *cum laude* (with praise); *multa cum laude* (with great praise); *summa cum laude* (with the highest praise). Nothing is easier than to get the first, but it requires a clever and learned man to obtain the last. You will now understand why *certain persons* have a Ph. D. In fact, I look upon the title of Doctor as a very empty one, unless I see in a man's diploma that he has passed a severe examination. To be a fellow of any English Royal Society is worth a thousand Giessen Ph. D.'s. *It proves ability of a very high order*, especially when the candidate is carried unanimously. The M.D., or Ph. D., however, now only proves that a man has visited the town to pay for it." The letter from a German student we believe to be too true; we hope, for the sake of science and literature, that the vile system of granting degrees will be abolished. How is the public to know, when a man sticks Ph. D. after his name, whether he has a first-class or a third-class diploma? Only *one grade* should be awarded.—*Mining Journal.*

GAS LIGHTING IN ROME.—The *Builder* of the 5th instant announces that a contract for lighting the Eternal City with gas has been at length concluded, after a negotiation of some years' duration, and that the works are to be commenced forthwith. Our own direct information does not exactly confirm this intelligence, though we believe the matter will probably be arranged at an early period; but, as the gentleman through whom the negotiations are stated by our contemporary to have been conducted is a relative of its editor, the *Builder* may possibly be better informed upon this subject than we are.

ACCIDENT AT THE SOUTH METROPOLITAN GAS WORKS.—An accident creating much unnecessary alarm in the neighbourhood, occurred at these works on Wednesday, the 19th ultimo, at about half-past nine in the morning, and of which an exaggerated account appeared in the daily papers. One of the regulating valves having become slightly deranged in its action, the second foreman, with an assistant, were engaged in its repair, when an indiarubber bladder, which had been introduced within the main on the street side, as a temporary valve to cut off the gas from flowing backwards, suddenly burst, and thus allowed the entire of the gas from an 18-inch main to escape into the valve-house, where the valve-man had imprudently, a short time previously, lighted a fire for the purpose of warming his breakfast. Ignition speedily took place, by which three men were somewhat seriously injured, and the valve-house, with its contents, destroyed. The fire was extinguished in about quarter of an hour, after doing damage to the extent of about £120. The three men are doing well, and will soon be convalescent.

IMPERIAL CONTINENTAL GAS ASSOCIATION.—At the half-yearly general meeting of this company, held on the 12th ult.—M. Wolverley Attwood, Esq., in the chair—dividends were declared for the half year ending Dec. 31, 1851, of £1. 7s. 6d. per (£42) share on the first capital, £2. 2s. 6d. per (£41) share on the second capital, and £2 per (£43. 10s.) share on the third capital, free of income tax; and upwards of £30,000 added to the reserve fund.

MANUFACTURE OF GAS FROM WOOD.—Two years ago Dr. Pettenkofer showed by experiment that a considerable amount of illuminating gas could be obtained from two ounces of wood. The practicability of the process on a large scale was then much doubted. It is now, however, in operation at Basle, and is about to be introduced in other towns in Switzerland, as well as in Norway and Sweden. The process is said to be far less expensive than the manufacture from coal, and furnishes a gas free from sulphuretted hydrogen, besides several useful by-products, such as charcoal, wood-tar, and vinegar.

Advertisements.

ADDISON POTTER,
WILLINGTON QUAY,
NEAR NEWCASTLE-UPON-TYNE,
Manufacturer of Clay Retorts, Fire Bricks, and every description of Fire Clay Goods.

LOSH, WILSON, and BELL,
NEWCASTLE-ON-TYNE,
Manufacturers of Bar Iron, Railway Bars, Forge and Engine Work, Cast Iron Goods, and STEWART'S PATENT CAST IRON GAS AND WATER PIPES.
Office, No. 7, Size-lane, London.

G. E. DEELEY, Harrow-bridge Iron Foundry, Stratford, Essex (late of the Red Lion Foundry, Whitechapel), Manufacturer of STEAM ENGINES, Boilers, Gasholders and Gas Apparatus, Tanks, Backs, Wrought and Cast Iron Roofs, Girders, Columns, Stanchions, Socket and Flange Pipes; Rain-water Pipes, Heads, and Shoes; Garden and Field Rollers, Ploughshares and Points; Wrought iron Hurdles, Railing, and Carriage Gates; Pig and Sheep Troughs, &c.
N.B. Smiths' Work in general.

PATENT FIRE-CLAY RETORTS.—O. BROTHERS and COMPANY, late O. Brothers and Railtons, Manufacturers of O. Brothers's Patent, beg to state that these Retorts, being made in one entire operation, and in one piece, of any required shape, length, breadth, and height, are not liable to cracks and fissures, of which there is a just and general complaint, and they are consequently superior to, and cheaper than, any hitherto manufactured.

REDUCED PRICES AS UNDER:

Shape.	Sizes.	Length.	Thickness.	Price at Railway, Blackburn.	Price per foot run, of any required length, at Blackburn.
		feet.	in.	£ s. d.	s. d.
Dee.....	13 in. by 13 in.	8	2½	2 8 0	6 0
„	14 in. by 12 in.	8	2½	2 16 0	7 0
„	16 in. by 13 in.	8	2½	3 0 0	7 6
„	18 in. by 14 in.	8	2½	3 8 0	8 6
„	19 in. by 13 in.	8	2½	3 8 0	8 6
„	20 in. by 14 in.	9	3½	4 1 0	9 0
„	24 in. by 15 in.	8	2½	4 4 0	10 6
Round.....	15 in. by 15 in.	8	2½	3 0 0	7 6
„	15 in. by 15 in.	10	2½	3 15 0	7 6
„	18 in. by 18 in.	8	2½	3 14 0	9 3
Oval Retort	18 in. by 12 in.	8	2½	3 8 0	8 6

References and further particulars may be obtained on application to the Patentee, Gas Works, BLACKBURN.

METER INDICES.

J. CLUER, Gas Meter, Index Maker, and Model Machinist, No. 1, Bowling-green-lane, Clerkenwell, London.
INDICES and all other Apparatus for Gas Meters of every size and kind, made on the shortest notice, of the best metal, and of superior workmanship.

JOSEPH BOULTON, Gas Meter Manufacturer, No. 1, COPPICE-ROW, CLERKENWELL, LONDON, begs to call the attention of Gas Companies and the public in general to his improved GAS METER, containing all the latest improvements.
J. B. warrants all Meters to be manufactured of the best materials and workmanship, the wheels, &c., being of metal. Old Meters repaired on the lowest terms.

SHEARS AND SONS'
PATENT DRY GAS METERS
Are supplied to Gas Companies and the Public as the best and simplest Dry Gas Meters in use. They are acknowledged to be of first-rate workmanship and accuracy of registration.—Shears and Sons continue to supply these Meters on the most favourable terms; and they also manufacture Wet Gas Meters, to which they apply their Patent Indices.
BANKSIDE, LONDON.
Feb. 7, 1852.

WEST and GREGSON,
GAS METER MANUFACTURERS, BRASSFOUNDERS, &c., UNION-STREET, OLDHAM.
Station and Experimental Meters, Gas Pressure Registers, Gauges, Experimental Gasholders, Governors, Slide Valves, &c. &c.

HARPERS AND MOORE,
DELPH FIRE CLAY WORKS, STOURBRIDGE.
London Depot, No. 7, WENLOCK-ROAD, CITY-ROAD,
where they have always on hand a large stock of their best Stourbridge Fire Bricks, Lumps, Quarries, Burrs, Gas Retorts, Crucibles, &c. &c.
Fire goods of every description made to order.

ESTABLISHED IN 1834.

S. KING, Gas Meter Manufacturer, 21, Cock-lane, West Smithfield, London.
Meters made of the best materials and workmanship, with all the recent improvements, and warranted correct in registration.

M. SHEEN, Gas and Railway Lantern Maker, 90½, Holborn-hill, begs to inform Managers of Gas Works, &c., that she continues to contract and supply Lanterns on reasonable terms, and keep them in repair by the year.

GEORGE and SAMUEL CUTLER,
GASHOLDER MAKERS,
No. 8, WENLOCK-ROAD, CITY-ROAD,
LONDON.
Contracts for Tanks, Gasholders, Roofs, Purifiers, and all descriptions of Gas Apparatus executed on the most reasonable terms. Improved Slide Valves, Steam and Range Boilers, and Smiths' Work, of the best materials and workmanship.

PATENT FLEXIBLE GAS TUBING.

JAMES LYNE HANCOCK'S Vulcanized Indiarubber Hose Pipes and Tubing. Manufactory (and Warehouse), Goswell-mews, Goswell-road, London.
Gas Companies, Engineers, Gas Fitters, and the Trade generally, are respectfully informed this Tubing is now manufactured to any size, from ¼ inch bore and upwards, in 100-feet lengths, and perfectly cylindrical, either with or without a spiral wire inside.
VULCANIZED GLAZED FLEXIBLE TUBING, from ¼ inch up to 1 inch diameter, made in 24-feet lengths; or, covered with silk or worsted, up to 100 feet.
VULCANIZED HOSE, for FIRE ENGINES, BREWERS' USE, and for standing great pressures, (Rubber and Cloth combined), made to any length or size to fit the necessary screws, &c.
VULCANIZED INDIARUBBER AIR-TIGHT BAGS, made any size, for Gas Mains, with flexible tubes attached, and fitted with stopcocks complete.

Share List.

(Dir ectors and Managers of Gas Works are earnestly requested to enable us to rectify any errors and fill up the omissions in the following List.)

The Companies whose names are printed in italic type are incorporated by Act of Parliament.

Number of Shares issued.	Amount per Share	Name of Company.	Amount paid up per Share	Dividend per Cent. per Ann.	Price.
	£	**ENGLAND.**	£ s. d	£ s. d	£ s. d
		Aberdare			
		Aberystwith			
		Abingdon			
		Accrington £7000		5 0 0	
		Albrighton			
		Alcester			
		Alford, Lincolnsh.			
		Alfreton			
		Alnwick			
		Alston Moor			
250	10	Alton	10 0 0	5 0 0	10 0 0
800	5	Altrincham	5 0 0	6 0 0	
		Amlwch			
160	10	Ampthill	10 0 0	5 0 0	10 0 0
350	10	Andover	10 0 0	6 0 0	11 0 0
		Appleby			
		Arundel			
		Ashbourn, Derby			
		Ashburton			
		Ashby-de-la-Zouch			
		Ashford, Kent			
1600	25	*Ashton-under-Lyne*	25 0 0	10 0 0	52 0 0
		Atherstone			
		Axminster			
200	20	Aylesbury	20 0 0	5 0 0	21 0 0
		Aylsham, Norfolk			
		Bacup, Lancashire			
		Bakewell			
		Baldock			
140	25	Banbury	25 0 0	10 0 0	50 0 0
		Bangor			
500	5	Barking, Essex	4 10 0	5 11 0	5 0 0
250	10	Barnard Castle	10 0 0	5 10 0	10 15 0
		Barnet			
		Barnsley £6000		7 10 0	
100	20	Barnstaple	20 0 0	5 0 0	23 0 0
		Barton			
120	25	Basingstoke	25 0 0	8 0 0	28 0 0
2400	20	*Bath*	16 0 0	6 0 0	25 to 30
		Battle £2000		6 0 0	
56	26½	Bawtry	26 10 0	5 0 0	25 0 0
		Beaumaris			
		Beccles, Bungay, and Lowestoft			
		Bedford			
		Bedworth			
		Belford			
		Bedale, Yorkshire			
		Belper			
		Beminster			
		Berkhempstead			
700	5½	Berwick-on-Tweed	5 10 0	6 8 0	5 15 0
		Beverley			
		Bewdley			
280	10	Bideford	10 0 0	6 0 0	10 10 0
		Biggleswade			
160	10	Bicester	10 0 0	5 0 0	10 0 0
		Bilston £15,100		8 0 0	
		Billericay			
		Bingley £7400		4 0 0	
		Birkenhead £70,000	35 0 0	3 0 0	35 to 37
2400	50	*Birmingham and Staffordshire*	50 0 0	10 0 0	96 to 97
	25	*Ditto*, new shares	7 10 0	10 0 0	10 pm.
928	75	*Birmingham*	75 0 0	10 0 0	149 to 151
		Bishop's Auckland			
140	25	Bishop's Stortford	25 0 0	5 0 0	24 0 0
		Blackburn £30,000		10 0 0	
		Blackpool			
		Blandford			
		Blythe			
		Bodmin			
		Bognor			
		Bolton £38,582		9 19 5	
		Boroughbridge			
		Boston £8000		10 0 0	
200	10	Bourn	10 0 0	5 0 0	
		Brackley			
		Bradford, Wilts			
		Bradford, Yorksh. £45,000		9 10 0	
		Brampton, Cumb.			
		Brandon, Suffolk			
		Brecon			
		Bridge-end, Glam.			
		Brierly Hill			
2250	20	*Brighton*	20 0 0	5 0 0	14 to 15
1125	20	,, new shares	16 0 0	5 0 0	
		Brighton and Hove £50,276		3 10 0	
4250	20	*Bristol*	20 0 0	9 0 0	37 0 0
1725	25	*Bristol and Clifton*	25 0 0	6 0 0	25 0 0
		Brixham			
		Braintree			
750	50	*Brentford*	50 0 0	6 0 0	44 to 46
800	25	,, new shares	11 0 0	6 0 0	11 0 0
		Brentwood			
		Bridgwater £6000		5 0 0	
400	10	Bridlington	10 0 0	5 0 0	10 0 0
		Bridport			
		Brigg			
		Broadstairs			
100	50	Bromley, Kent	50 0 0	6 0 0	52 10 0
		Bromsgrove			
		Broughton			
120	10	Bruton	10 0 0	4 0 0	8 0 0
100	25	Buckingham	25 0 0	5 0 0	25 0 0
		Bungay (see Becls.)			
		Burford			
		Burnley £19,946		4 10 2	
		Burslem & Tunstall			
		Burton-on-Trent			
		Bury, Lanc. £6570			
		Bury St. Edmund's		5 0 0	
200	10	Buxton	10 0 0		
		Callington			
		Calne, Wilts			
		Camborne			
		Cambridge £34,560		7 0 0	
240	50	*Canterbury*	50 0 0	6 0 0	57 to 58
240	25	*Ditto*, second issue	25 0 0	6 0 0	28 to 29
		Cardiff £12,000		7 10 0	
		Carmarthen			
		Castleford			
		Chapel on the Frith			
		Chard			
		Chatteris			
		Cheadle			
		Chelmsford			
		Cheltenham £18,732		8 10 0	
		Chepstow			
		Chertsey			
230	10	Chesham, Bucks	10 0 0		
		Chester			
		Chester-le-Street			
		Chesterfield £13,123		4 17 6	
240	25	Chichester	25 0 0	6 0 0	30 0 0
		Chippenham			
		Chipping Norton			
		Chirk			
		Chorley			
		Christchurch			
		Chudleigh			
		Cirencester			
		Clifton (Bristol and			
		Cleckheaton, York.			
		Clitheroe			
		Cockermouth			
		Colchester			
		Collumpton			
		Colne, Lancashire			
		Coleford, Gloucest.			
		Coggeshall			
		Congleton £5000		5 0 0	
		Cowbridge			
		Corsham			
800	25	*Coventry*	25 0 0	6 0 0	24 to 25
		Cowes			
		Crewkerne			
		Croydon ... £20,000		5 0 0	
		Cranbrook ... £1900		5 0 0	
		Crayford			
		Crediton			
		Crewe, Cheshire			
		Cricklade			
		Darlaston			
		Darlington			
250	20	Dartford	20 0 0	7 10 0	27 0 0
		Dartmouth			
125	20	Daventry	20 0 0	6 0 0	21 8 0
		Dawley, Salop			
		Dawlish			
		Dedington			
500	6	Denbigh	6 0 0	5 0 0	6 0 0
820	10	Deptford	10 0 0	5 0 0	4 10 0
325	50	*Derby*	50 0 0	10 0 0	
90	20	Dereham (East)	20 0 0	4 10 0	
1000	5	*Dewsbury*	5 0 0	10 0 0	8 12 6
		Devizes			
4000	5	*Deconport*	5 0 0	6 0 0	6 5 0
		Doncaster			
280	25	Dorchester	25 0 0	5 0 0	30 0 0
120	25	Dorking	20 10 0	5 0 0	21 10 0
		Douglas, Isle of M.			
209	56¼	*Dover*	56 10 0	5 15 0	71 to 72
		Downham			
		Driffield			
		Droitwich			
600	20	*Dudley*	20 0 0	4 0 0	20 to 21
		Droylsden			
		Dunmow			
		Dunstable			
		Durham			
276	9	Dursley, Gloster	9 0 0	5 10 0	8 0 0
300	10	Eastbourne			
		East Grinstead			
		Elland			
		Ellesmere			
		Eltham			
		Enfield			
300	19	Epsom and Ewell	19 0 0		
		Evesham			
		Exeter £40,000		10 0 0	
		Exmouth			
		Eye, Suffolk			
64	25	Fakenham	25 0 0	5 0 0	25 0 0
		Falmouth			
		Fareham			
120	25	Farnham	25 0 0	10 0 0	42 0 0
		Farringdon			
		Faversham			
		Ferrybridge			
		Fleetwood			
300	10	Folkestone	10 0 0	10 0 0	15 0 0
240	10	,, new shares	8 0 0	10 0 0	13 0 0
		Fowey			
240	5	Framlingham	5 0 0	5 0 0	5 0 0
		Frome			
		Garstang			
		Gillingham, Dorset			
		Glastonbury			
		Glossop ... £10,000		9 0 0	
1000	25	*Gloucester*	25 0 0	7 10 0	28 0 0
		Gomersal			
		Godalming			
		Gosport			
		Grantham			
20		Gravesend	20 0 0	5 0 0	21 0 0
1000	10	*Great Grimsby*	8 0 0	8 0 0	12 to 12¼
1000	25	Guildford	25 0 0	4 0 0	20 0 0
		Guisborough			
		Hadleigh			
		Hales Owen			
300	6	Halesworth	6 0 0	7 10 0	5 10 0
		Halifax £15,000		10 0 0	
		Halstead			
		Hampton Court			
		Harrogate £10,000		5 0 0	
		Hartlepool £15,137		7 10 0	
		Haslingden, Lancsh.			
330	50	Hastings and St. L.	50 0 0	6 0 0	60 0 0
		Haverhill			
		Haworth, Yorks.			
		Hayle			
		Helstone			
		Hemel Hempstead			
300	10	Henley-on-Thams.	10 0 0		
		Hereford £5300		4 0 0	
		Herne Bay			
270	10	Hexham	10 0 0	7 0 0	12 0 0
		Heywood £10,000		5 0 0	
		Highworth (Wilts)			
230	10	Hinckley	10 0 0	5 0 0	7 0 0
		Hindley, Lancash.			
		Hitchen			
		Hythe			
		Hoddesden			
		Holbeach			
		Holmfirth £8880		3 10 0	
		Holyhead			
		Holywell (see British Provincial)			
		Honiton			
		Horncastle			
10		Houghton-le-Sprg.	10 0 0	8 0 0	
		Horsham			
		Howden			
		Hull, Sculcoats (see British Provin.)			
		Hull, £11,712. 10s.		5 0 0	
		Hunmanby			
210	10	Hungerford	10 0 0	5 0 0	16 0 0
		Huddersfield			
520	5	High Wycombe	5 0 0	6 0 0	5 0 0
		Idle and Eccleshill			
		Ilkeston			
		Ilminster			
		Ilford			
		Ilfracombe			
		Ironbridge			
1400	10	*Ipswich*	10 0 0	8 0 0	15 0 0
1400	10	,, new shares	7 10 0	8 0 0	12 10 0
800	25	*Isle of Thanet*	20 0 0	5 0 0	20 to 21
		Kendal £9100		8 15 0	
		Kenilworth			
		Keswick			
100	25	Kettering	25 0 0	5 0 0	25 0 0
		Kiddermins. £10000		5 0 0	
		King's Langley			
		Kington, Hereford			
		Kirkby Lonsdale			
		Kirkham, Lanc.			
		Knutsford			
		Lancaster			
		Llanelly £3000		5 0 0	
		Llandovery			
		Leamington Priors £22,500		6 0 0	
		Leatherhead			
		Ledbury			
		Leeds Old Comp. old stk., £60,300		10 0 0	
		new ,, £23,775		6 0 0	
		Leeds New £60,000		10 0 0	
		Leek			
		Leicester ... £36,330		7 0 0	
		Leigh			
135	20	Leighton Buzzard	20 0	5 0 0	
		Leominster			
		Leyburn, Yorksh.			
		Liskeard			
330	25	Lewes	25 0 0	5 0 0	25 0 0
		Lincoln £8000		10 0 0	
		Leyland, Lancash.			
		Littlehampton			
250	20	Lichfield	20 0 0	10 0 0	30 0 0
		Liverpool United	100 0 0	10 0 0	206 to 208
		,, ¼ sh.	25 0 0	10 0 0	51 to 52
		Langport			
		London Compss.—			
40		*British*	18 0 0	1 18 10	12 0 0
5000	20	,, Provincial—(Holywell, Hull, Norwich, Potteries, Trowbridge)	20 0 0	7 0 0	18 to 20
	20	,, Prov., new	10 0 0	12 0 0	10 to 12
4000	25	*Commercial*	25 0 0	6 0 0	27 to 29
2000	25	,, new shares	2 10 0	6 0 0	par to 1pm
		,, debentures £12,000			
12,000	50	*Chartered*	50 0 0	4 0 0	38 to 39
6000	50	,, new shares	10 0 0	4 0 0	7¼ to 8
2000	150	*City of London*	150 0 0	4 0 0	125 to 130
4000	50	*Equitable*	50 0 0	2 10 0	25 to 26
		,, debentures £46,000			
10,000	20	European—(Amiens, Boulogne, Caen, Havre, Nantes, and Rouen)	20 0 0	5 0 0	10 to 12
2000	20	,, do. new	7 0 0	5 0 0	5 to 7

Number of Shares issued.	Amount per Share	Name of Company.	Amount paid up per Share	Dividend per Cent. per Ann.	Price.
	£		£ s. d	£ s. d	£ s. d
15,000	10	*Gt.Cntl.Consumers*	10 0 0	10 0 0	10 to 12
		Impl.Continental—First capital (Amsterdam, Berlin, Ghent, Hanover, Lille, Rotterdam)	42 0 0	6 11 0	44 to 46
7000	50	Second capital—(Aix la Chapelle, Antwerp, Bordeaux, Brussels, Cologne, Frankfort-on-Maine, Haarlem, Marseilles, Toulouse Vienna)	41 0 0	10 7 0	68 to 70
	50	Third capital	43 10 0	9 4 0	65 to 70
10,000	50	*Imperial*	50 0 0	6 0 0	70 to 72
3000	50	„ new shares	45 0 0	6 0 0	60 to 62
		„ debentures £50,500			
4000	40	*Independent*	40 0 0	6 0 0	46 to 47
3000	50	*London*	50 0 0		2 10 0
6000	25	„ preference	10 0 0	6 0 0	10 0 0
3000	50	„ 2nd do.	50 0 0		15 to 18
9000	50	*Phœnix*	49 0 0	3 10 0	24 to 25
1000	100	*Ratcliff*	90 0 0	5 0 0	60 to 65
4000	25	*South Metrop.*	25 0 0	5 0 0	22 to 23
9000	50	Surrey Consumers' United General—(Cork, Dublin, Limerick)	50 0 0	2 0 0	18 to 19
12,500	20	Western	20 0 0		7 0 0
		Lostwithiel		2 0 0	
		Loughborough			
240	25	*Louth*	25 0 0	6 0 0	26 10 0
		Lowestoft (see Bec.			
611	5	Ludlow Union	5 0 0	6 0 0	5 0 0
		Luton			
		Lutterworth			
		Lyme Regis			
		Lymington			
		Malmesbury			
		Macclesfield 32,000		3 15 0	
		Maidenhead			
360	50	*Maidstone*	50 0 0	10 0 0	90 0 0
		Maldon			
		Marlborough			
		Malton (New)			
		Malvern			
		Manningtree			
		Mansfield £5000		10 0 0	
		March			
		Margate (see I. of T.			
		Market Deeping			
		Market Drayton			
132	25	Market Harboro'	25 0 0	6 0 0	30 0 0
		Market Raisin			
		Market Weighton			
		Marlow			
370	10	Maryport	10 0 0	6 0 0	12 0 0
		Melksham			
		Melton Mowbray			
		Merthyr Tydvil			
		Mere			
		Middleton £9030		5 0 0	
		Midsummer Norton			
		Middlesboro'			
		Mildenhall			
		Mitcham			
		Mold			
700	10	Monmouth	10 0 0	5 0 0	
		Monk Wearmouth			
		Moreton in Marsh			
		Morley			
		Mottram			
		Morpeth			
		Nantwich			
		Neath			
		Needham Market			
		Newark £5000		10 0 0	
250	20	Newbury	20 0 0	5 0 0	20 0 0
13,000	5	Newcastle & Gateshead Union	5 0 0	8 0 0	8 0 0
		Newcastle-under-Lyne £6200		4 0 0	
600	5	Newmarket	5 0 0	6 0 0	5 0 0
		Newnham, Glost.			
		Newent			
		New Mills £9115		8 0 0	
		Newport, M. £11720			
320	50	*Newport, Isle of W.*	38 0 0	4 0 0	5 0 0
		Newport Pagnell			
		Newport, Salop			
		Newton Abbot			
		Newton, Lanc.			
		Northallerton			
		North Walsham			
542	20	*Northampton*	18 0 0	10 0 0	27 0 0
		Northwich			
		Norwich (see British Pro. £40,000		7 0 0	
900	50	*Nottingham*	50 0 0	10 0 0	
900	50	New shares		10 0 0	
		Nuneaton			
		Oakham			
		Oakhampton			
200	10	Odiham, Hants	10 0 0	4 0 0	10 0 0
		Oldham			
		Olney			
		Ongar			
		Ormskirk			
		Otley, Yorkshire			
		Oundle			
120	150	*Oxford*	150 0 0	8 0 0	260 0 0
		Over Darwen £8000		5 0 0	
		Padstow			
		Pately Bridge, Yrk.			
250	20	Penrith	15 0 0	6 10 0	21 0 0
		Penryn			
		Penzance			
200	10	Petworth	10 0 0	8 0 0	12 0 0
		Petersfield			
		Pickering			
3000	10	*Plymouth*	10 0 0	6 0 0	11 0 0
		Pocklington			
		Pontefract			
		Pontypridd			
400	10	Poole	10 0 0	5 0 0	10 0 0
		Port Madoc			
600	50	*Portsea Island*	53 0 0	5 0 0	45 to 47
400	10	Prescott	9 0 0	4 13 4	7 0 0
3000	20	*Preston*	20 0 0	10 0 0	
		Pwllheli			
		Pudsey £12,000		5 0 0	
		Radcliff and Pilkington £9000		4 12 10	
		Ramsay, I. of Man			
		Ramsgate (see I. of T.			
		Ravenglass			
1000	10	*Reading*	10 0 0	4 0 0	7 0 0
500	20	*Reading Union*	20 0 0	6 0 0	17 0 0
		Redditch			
		Redruth			
		Reigate			
		Retford (East)			
		Rhyl			
		Richmond (Surrey)			
		Ringwood			
		Ripon			
		Rochester and Chatham £20,000		6 0 0	
		Rochford			
		Rockingham			
		Romford			
		Ross			
215	25	*Rotherham*	25 0 0	6 0 0	40 10 0
		Royston			
		Ruabon			
		Rugby			
		Rugeley			
		Runcorn £11,000		7 10 0	
		Ruthin			
500	10	Ryde	10 0 0	6 0 0	12 0 0
		Rye			
		Romsey			
		Saddleworth			
225	20	Saffron Walden	20 0 0	3 15 0	19 0 0
		St. Austel			
		St. Asaph			
		St. Colomb			
		St. Helen's £7500		7 10 0	
		St. Helier's (Jersey)			
		St. Ives, Hunting.			
		St. Ives, Cornwall			
250	10	St. Neot's	10 0 0	8 0 0	12 0 0
		St. Peter's Port, (Guernsey)			
320	25	Salisbury	25 0 0	6 0 0	28 to 30
		Sandbach			
140	10	Saxmundham	10 0 0	5 0 0	10 0 0
		Scarborough			
		Sedburgh			
		Selby			
		Settle			
290	10	Sevenoaks	10 0 0	5 0 0	10 0 0
		Shaftesbury			
5400	25	*Sheffield United*	24 0 0	8 6 8	30 0 0
		Shelton, Potteries (see Brit. Prov.)			
		Shepton Mallet			
		Sherborne			
2914	5	Shields (Tyneside)	5 0 0	3 0 0	5 0 0
		Shields (South)			
		Shiffnal, Salop			
1000	5	*Shipley*	5 0 0	6 0 0	5 12 6
		Shipston-on-Stour			
		Shoreham			
		Shrewsbury £10,000		7 0 0	
400	10	Skipton	10 0 0	4 0 0	11 0 0
		Sleaford			
250	10	Slough	10 0 0		
		Snaith			
		Soham			
		Southwold			
		South Molton			
1000	50	*Southampton*	32 0 0	5 0 0	
		Sowerby, Yorksh.			
		Stretford			
		Stokesly			
		Stafford £10,000		5 0 0	
		Staines and Egham			
		Staley Bdg. £15,000		10 0 0	
		Stamford £11,250		3 0 0	
		Stockton-on-Tees £7980		9 5 0	
840	9½	Stockton, New	9 10 0	9 0 0	8 0 0
950	10	Stoke-upon-Trent	10 0 0	7 0 0	11 10 0
500	10	„ new shares	6 0 0	7 0 0	7 10 0
		Stone, Staffordsh.			
		Stoney Stratford			
		Stourbridge			
		Stowmarket			
150	20	Stratford-on-Avon	20 0 0	7 10 0	30 0 0
		Stroud			
169	10	Swaffham	10 0 0	5 0 0	5 10 0
		Swansea £9000			
		Sudbury			
		Sunderland, old			
6400	5	*Sunderland*, new	5 0 0		
		Sutton			
		Swindon			
		Sydenham			
2800	5	*Taunton*	5 0 0	None	2 10 0
		Tadcaster			
		Tamworth			
		Tavistock			
		Teignmouth			
		Tenbury			
		Tenby			
		Tenterden £2000		2 10 0	
		Tetbury, Gloster			
		Tewkesbury			
		Thame			
		Thetford			
		Thirsk			
		Thornbury			
		Thorne			
		Tiverton			
670	5	Todmorden		3 0 6	
		Torquay			
		Torrington, Devon			
		Totnes			
		Totnes Consumers			
4000	5	Tottenham		3 10 0	6 0 0 3 0 0
		Towcester			
200	10	Tring		10 0 0	5 0 0 10 0 0
		Trowbridge (see British Provin.)			
75	50	Truro		50 0 0	2 0 0
		Tunbridge			
		Tunbridge Wells			
		Ulverston			
		Uppingham			
240	5	Upton-on-Severn		5 0 0	5 0 0 5 0 0
		Usk, Monmouth			
		Uttoxeter			
		Uxbridge			
1000	25	*Wakefield*, old capl		25 0 0	5 0 0 25 0 0
1600	5	„ new „		5 0 0	6 0 0 5 0 0
300	10	Wallingford		10 0 0	5 0 0 8 0 0
		Wandsworth			
		Wantage			
		Warrington £23304			10 0 0
100	10	Wareham		10 0 0	3 10 0 8 0 0
120	25	Warminster		25 0 0	5 0 0 27 0 0
		Warth			
		Warwick £15,000			6 0 0
		Watford			
		Welchpool, Mntgy.			
		Wellingborough			
		Wellington, Salop			
		Wellington, Smrst.			
		Wells, Smrst. £5000			7 10 0
		Westbury			
		Weston-sup.-Mare			
2000	5	West Ham		5 0 0	6 0 0 5 0 0
		Whitby			
		Whitchaven			
		Whitstable			
		Whittlesea			
		Wigan £10,160			10 0 0
		Willenhall			
		Winchelsea			
		Winslow			
240	10	Wimborne Minster	10 0 0		
		Wincanton			
360	50	Winchester	50 0 0	6 0 0	
900	12½	Windsor	12 10 0	10 0 0	23 0 0
		Witham			
		Witney			
4448	10	*Wolverhampton*	10 0 0	7 10 0	17 10 0
		Woburn			
210	10	Wokingham	10 0 0		10 0 0
		Woodbridge			
		Wooler			
		Wotton-un.-Edge			
		Worcester £29,000		8 0 0	
		Workington			
		Worksop & Radford			
		Wirksworth			
		Worthing			
		Wrexham			
		Woolwich Equitbl.			
		Woolwich Consms.			
		Woolwich (North)			
		Wymondham			
		Yarm			
795	20	Yarmouth	20 0 0		15½ to 16½
		Yeadon, near Leeds			
		Yeovil			
		York Untd. £55,000		7 0 0	
		SCOTLAND.			
	5	Aberdeen	3 0 0		3 16 6
		Airdrie			
		Alloa			
		Annan			
		Anstruther			
		Ardrossan			
550	20	Arbroath	20 0 0	7 10 0	27 10 0
		Auchterarder			
750	2	Auchtermuchty	2 0 0	6 0 0	2 10 0
		Ayr, old			
		Ditto, new			
		Banff			
		Barrhead			
		Bathgate			
		Beith			
		Bervie			
		Biggar			
		Blairgowrie			
400	6	Borrowstowness	6 0 0	5 0 0	8 0 0
		Brechin			
	2	Bridge of Allan			
		Broughty Ferry	2 0 0	5 0 0	2 0 0
		Burntisland			
		Callen			
		Campbelton			
		Clackmannan			
		Coatbridge			
		Coldstream			
		Collinsburgh			
		Comrie			
		Crieff			
		Crail, Fife			
		Cumbernauld			
		Cumnock			
600	5	Cupar Angus	5 0 0	6 0 0	5 10 0
250	10	Cupar Fife	10 0 0	7 10 0	14 0 0
		Dalkeith			
		Denny			
		Dingwall			
		Dornoch			
		Douglas			
		Dumbarton			
400	20	Dumfries	14 0 0	5 0 0	20 0 0
		Dunbar			
		Dunblane			

Number of Shares issued.	Amount per Share	Name of Company.	Amount paid up per Share	Dividend per Cent. per Ann.	Price.
	£		£ s. d	£ s. d	£ s. d
	23¾	*Dundee*, old £29,687	23 15 0	8 8 0	30 10 0
8000	5	*Dundee, new*	5 0 0	4 0 0	4 0 0
860	10	Dunfermline	10 0 0	6 0 0	12 12 0
		Dunkeld			
		Dunse			
		Dysart			
6000	25	*Edinburgh Gas Co.*	25 0 0	10 0 0	52 10 0
	25	„ *and Leith Co.* £98,640	18 0 0	7 10 0	27 13 6
		Elie			
		Elgin			
		Falkirk, old			
		„ new			
		Falkland			
		Ferry Port on Craig			
		Fochabers			
		Forfar			
		Fort William			
		Fraserburgh			
		Galashiels			
		Garlieston			
		Gatehouse n. Fleet			
		Girvan			
	25	*Glasgow* £122,500	25 0 0	10 0 0	50 0 0
15000	10	*Glasgow City and Suburban*	9 0 0	7 15 0	17 7 6
		Grangemouth			
		Grahamston			
		Haddington			
		Hamilton £7500		8 0 0	
		Hawick			
		Helensburgh			
		Huntly			
		Inverary			
400	1	Inverkeithing	1 0 0	5 0 0	1 0 0
1200	10	*Inverness Gas and Water*	10 0 0	7 10 0	15 0 0
2400	5	„ new shares	1 5 0	7 10 0	2 5 0
		Irvine			
		Jedburgh			
		Johnstone, near Paisley			
		Keith			
		Kelso		10 0 0	
		Kilmarnock			
		Kincardine			
		Kinghorn			
		Kingskittlo, Fife			
		Kinross			
		Kirkaldy			
320	5	Kirkcudbright	5 0 0	5 0 0	5 0 0
1000	3	Kirkintulloch, near Glasgow	3 0 0	5 0 0	3 0 0
227	5	Kirkwall	5 0 0	5 0 0	4 10 0
518	5	Kirriemuir	5 0 0	6 0 0	
		Lanark			
		Largo, near Leven			
		Largs			
		Lasswade, n. Edin.			
		Lauder			
		Leith			
		Leslie, Fife			
		Lesmahago			
		Leven			
		Linlithgow			
		Linton, n. Nobleh.			
		Lochee, n. Dundee			
		Lochgilphead			
		Lochwinnock, near Paisley			
1200	1	Markinch	1 0 0	7 10 0	1 5 0
		Mauchline			
		Maxwell-town, n. Dumfries			
		Maybole, Ayrshire			
		Maryhill, near Glasgow			
		Melrose			
718	12	Mid & East Calder	2 0 0		2 0 0
192	5	Moffat	5 0 0		
	13½	Montrose	13 10 0	7 11 1	
		Musselburgh			
		Nairn			
		Neilston, n. Glasg.			
		Newmills, near Kilmarnock			
		Newburgh, Fife			
		Newton-on-Aye			
		Newton Stewart			
		North Berwick, n. Haddington			
		North Queensferry			
		Oban			
		Peebles			
800	25	Perth	25 0 0	4 16 0	22 10 0
	5	„ new	5 0 0		2 7 6
		Peterhead			
		Pittenweem			
		Pollokshaws, near Glasgow			
		Port Glasgow			
		Portobello, n. Edin.			
		Prestonpans			
		Rutherglen, near Glasgow			
		Renfrew, n. Paisley			
		Saltcoats			
		Sanquhar			
		Selkirk			
		South Queensferry			
		St. Andrew's			
		Stewarton			
		Stirling			
1300	5	Clonmel Consumrs	5 0 0	5 0 0	5 0 0
		Drogheda			
19,000	10	*Dublin Consumers*	5 0 0	7 0 0	6 0 0
		Dublin Hibernian (see United Gen.)			
160	25	Dundalk	25 0 0		22 0 0
		Dungannon			
871	5	*Downpatrick*	5 0 0	4 0 0	
		Enniskillen			
		Enniscorthy			
240	25	Galway	25 0 0	10 0 0	32 0 0
400	10	Kilkenny	10 0 0	8 0 0	11 5 0
		Larne			
		Limerick (see U.G.)			
1725	5	Limerick Consum.	5 0 0	5 0 0	5 0 0
600	15	Londonderry	15 0 0	6 13 4	21 10 0
500	7	Lisburn	7 0 0	7 10 0	7 0 0
520	10	Lurgan	6 0 0	6 0 0	6 0 0
		Mallow			
		Monaghan			
		Nenagh			
448	5	Newtownards	5 0 0	4 0 0	5 0 0
		New Ross			
		Newry			
		Omagh			
125	20	Portadown	20 0 0	6 0 0	20 0 0
600	10	Sligo	10 0 0		
		Tipperary			
		Tralee			
		Waterford			
		Wexford			
		Stonehaven			
		Stonhouse, Lanrks.			
		Stornoway			
		Stranraer			
		Strathaven, near Hamilton			
		Thurso			
		Tillicoultry, n. Alloa			
800	1	Tranent	1 0 0		1 0 0
		Troon			
		Wick			
		Wigton			
		Wemyss	4 10 0		

IRELAND.

Number of Shares issued.	Amount per Share	Name of Company.	Amount paid up per Share	Dividend per Cent. per Ann.	Price.
	£		£ s. d	£ s. d	£ s. d
300	10	Armagh	10 0 0	8 0	14 10 0
		Ballinasloe			
700	50	*Belfast*	50 0 0		
		Ballymena			
		Ballymoney			
		Carrickfergus			
		Carlow, new			
		Cavan			
		Cork (see Un. Gen.)			
		Cookstown			
		Downpatrick			

The Gas Works in the undermentioned towns belong to private individuals:—

Abergavenny.	Ely.	Hertford.	Northfleet.	Sandwich.	Waltham Abbey.
Bridgenorth.	Farsley.	Holt.	Newport I. W. (new).	Seaham Harbour.	Ware. (2 works)
Carnarvon.	Gainsborough	Huntingdon.	Oswestry.	Sheerness.	Wem.
Chester, new.	Goole.	Hyde (Cheshire)	Peterborough.	Sidmouth.	Weymouth.
Deal.	Harleston.	Kingston-on-Thames.	Pontypool.	Sittingbourne.	Whitchurch (Salop).
Diss	Hatfield.	Lynn.	St. Alban's.	Spalding.	Wisbeach.

The Gas Works belong to the Corporations, or to Commissioners acting under special acts of Parliament, in the following towns:—

Carlisle.	Haverfordwest.	Manchester.	Rothesay.	Southport (Lanc.)	Walsall.
Cashel.	Keighly.	Milton (Kent).	Richmond (Yorkshire).	Stockport	Wells (Norfolk).
Coleraine.	Knaresborough.	Paisley.	Salford.	Strabane.	Youghall.
Greenock.	Lytham (Lanc.)	Rochdale.			

Price Current.

The following List of Prices is corrected by an eminent wholesale house in each trade up to the latest period:—

CASTINGS, per Ton.

Average Weight of Cast Iron Gas Pipes, per Yard.

1½ in.	2 in.	2½ in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	12 in.
16	21	28	33	51	70	89	107	126	149	177	208 lbs.

Retail Prices are 5 to 10 per cent. higher.	London.	Glasgow	Newcastle.	Wales.	Yorksh., Derbysh., and Staffdsh.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Pig Iron, No. 1	3 7 6	2 5 0	3 0 0	3 15 0	3 10 0
1¼ and 2 inches Socket Pipes	6 5 0	5 0 0	5 10 0	5 15 0	5 15 0
2½ and 3 do. do.	5 17 6	4 15 0	5 7 6	5 12 6	5 12 6
4 and 5 do. do.	5 15 0	4 12 6	5 5 0	5 10 0	5 10 0
6 inches and upwards do.	5 12 6	4 10 0	5 2 6	5 7 6	5 7 6
Extra for bends, branches, and connection	2 0 0	2 0 0	2 0 0	2 0 0	2 0 0
Retorts, 1st fusion, hot blast	5 5 0	..	..	4 17 6	5 0 0
Do. 2nd fusion, cold blast	5 15 0	4 10 0	4 17 6	5 5 0	5 5 0
Tank Plates, ¾ thick and above	5 10 0	4 17 6	5 0 0	5 7 6	5 17 6
Do. less than ¾	5 15 0	5 0 0	5 0 0	..	5 10 0
Plain Castings ex. models	5 15 0	5 0 0	5 0 0	5 10 0	5 10 0

COALS.

NEWCASTLE.

Unscreened.	s.	d.	
Whitwell Primrose	4	6	per ton.
Burnhope	5	3	„
Dean's Primrose	5	9	„
Pelton, Brancepeth, Medomsley	6	0	„
Pelaw	6	3	„
Eighton Moor, Felling Main, New Pelton, Peareth, South Pelaw, Waldridge, Washington Hutton, South Peareth	6	6	„
Ramsay's Cannel	12	0	„
Cowen's Cannel	12	0	„

DERBYSHIRE.

Clay Cross, Deep Main, and New Birchwood } 6s. 6d. per ton.

SCOTCH CANNEL.

Boghead	19	0	„
Kirkness best	23	0	„
Capeldrae, first quality	20	0	„
Ditto, second quality	10	0	„
Lothian	18	0	„
Lesmahago at Glasgow	16	6	„
Ditto at Leith	18	0	„
Arniston	16	0	„
Wemyss	15	0	„
Donibristle	10	6	„
Bridgeness, Kinneil	11	0	„
Knightswood	10	0	„
Lochgelly, Lumphinan	9	6	„

FIRE GOODS.

Best Bricks, 50s. per 1000, at Newcastle.
Do. Clay, 12s. per ton do.

LEAD.

Soft pig, £18. 10s. per ton.

WROUGHT IRON TUBING, subject to 40 per cent. Discount.

	2 inches.	1½ inch.	1¼ inch.	1 inch.	¾ inch.	½ inch.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Patent welded tubes, from 2 to 12 feet, per foot	1 8	1 0	0 10	0 7	0 5	0 4½
Ditto „ 6 in. to 18 in., each	3 0	2 0	1 9	1 3	1 0	0 9
Connecting pieces, or long screws	3 6	2 3	2 0	1 6	1 2	0 11
Bends, springs, and elbows, wrought iron	3 9	2 3	1 9	1 0	0 10	0 8
Tees, wrought or cast	4 0	2 6	2 0	1 6	1 1	0 10
Crosses, wrought or cast	4 6	3 0	2 6	2 0	1 6	1 2
Iron cocks	17 6	9 6	7 6	4 6	3 3	2 6
Ditto, with brass plug	28 0	16 0	13 0	7 0	5 6	4 6
Diminishing sockets, caps, plugs, and nipples	1 3	0 9	0 8	0 6	0 5	0 4
Plain sockets	1 0	0 8	0 7	0 5	0 4	0 3
Flanches	1 9	1 6	1 3	1 0	0 9	
Syphons, 2 quart	15 0	14 0	13 6	13 0	12 0	
Ditto 1 quart	11 6	10 6	10 3	10 0	9 6	

FREIGHTS, per Ton.

Coastwise—Newcastle.	s.	d.
Chatham & Roches.	5	6
Cork	7	6
Dover	6	0
Dublin	8	0
Exeter Quay	7	3
Folkestone	6	0
Hastings	7	0
Ipswich	5	2
Jersey	7	6
London	5	3
Lowestoft	4	2
Lynn	5	6
Margate	6	2
Portsmouth	6	6
Plymouth	6	3
Southampton	6	9
Weymouth	7	0
Yarmouth	4	2
Foreign.		
Amsterdam	8	6
Boulogne	6	9
Barcelona	15	0
Bordeaux	9	6
Calais	6	9
Dieppe	7	0
Hamburg	7	0
Havre	7	9
Lisbon	10	0
Rotterdam	7	3
Rouen	11	0
St. Petersburgh	11	0
Stettin	12	0
Trieste and Venice	17	0